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THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

VOL. XXX, pt. I]

MAY 15, 1944

[No. 1

Erosional Modification of Landmarks in Western Kansas During Historic Time

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ABSTRACT: A study of Castle Rock and Monument Rock, two prominent landmarks in Gove county, Kansas, based on their present condition, and on photographs taken in 1889, 1892 and 1894, demonstrates the amount of erosion during the past fifty years. This gives a measure for estimating total erosion under similar climatic conditions.

INTRODUCTION

TO THE geologist, it is axiomatic that the minor features of a landscape are ephemeral and ever-changing, and to all who have seen the work of rivers in flood the evidence for this is clear. The building and destruction of bars and islands, the undercutting of banks, the widening, deepening, or shifting of channels (cf. Smith, 1940), all these may be effected literally overnight. Although attesting to the efficacy of gradational processes, however, these more striking phenomena do not afford a direct basis for appraising the over-all modification of the land surface, and, indeed, may be misleading. They represent localized and intensified effects along comparatively narrow zones, bordering the stream channels, small in proportion to the total area of the drainage basins. Furthermore, erosion and deposition go hand in hand along rivers; the balance between the two is sometimes difficult to ascertain, and in fact is frequently shifted, even reversed, from time to time. And it may be added that the sedimentary materials directly involved in the work of streams are, to a large extent, undergoing a secondary reworking, having first been prepared and launched on their downward course by other less spectacular but more all-pervasive processes. Thus to

arrive at any adequate concept of the true rate and nature of modification of the landscape in a given region, it is necessary to look to the primary gathering grounds of the detrital materials—to the hills and slopes of the interstream areas, where the effects of erosion, however seemingly imperceptible, may be studied free from the complications of the minor epicycles of degradation and aggradation superimposed on the more steady progress of the erosion cycle proper.

Studies on the actual progress of weathering and slope recession are best made through a comparison of detailed records, such as photos, of the same localities at widely separated points in time. Opportunities for such comparisons come infrequently, and therefore are of particular interest when found, however limited or fragmentary the record. A typical example of such a study has been given by Bryan and La Rue (1927). A similar case, though in a distinctly different climatic and geologic setting, is provided in Gove county, western Kansas, where two prominent landmarks, Castle Rock and Monument Rock, photographed some fifty years ago, are seen to have changed appreciably during the intervening years. A detailed description of these features is given on the following pages, prefaced by a brief résumé of their climatic setting.

CLIMATE

Since climate plays an important part in governing the nature and rate of the erosional attack on rock, the broader significance of any particular example of erosional phenomena can be fully appreciated only in the light of its own climatic environment. The following summary of climatic conditions in Gove county (Flora, 1932) is therefore included in this paper.

The climate prevalent in Gove county may be classed as semiarid. Records at Gove, Ness City, Scott City, and Wakeeney indicate that the average annual rainfall is about 20 inches. In wet years, however, the rainfall ranges up to more than 30 inches, and in dry years it declines to less than 10 inches. The greater part of the rainfall comes during the summer months, reaching a maximum in June or July. January is the month of least precipitation. During the winter, a part of the precipitation occurs as snowfall, which averages close to 20 inches. Generally, however, the ground is not covered for more than a week at a time. Hail storms are common during the summer, and frequently are of sufficient severity to inflict serious damage on crops.

Temperature varies widely through the year. Average monthly temperatures as recorded at Wakeeney range from about 30° in January to about 77° in July. Average monthly maxima, however, range from about 43° to 92° for the same months, and average monthly minima from about 17° to 64°. The highest recorded temperature in the area was 111° at Wakeeney, and the lowest recorded temperature —31° at Healy. Daily temperature ranges are frequently 30°, and not uncommonly 40° to 50°. The average date of the last killing frost in spring is late in April or early in May, and the average date of the first killing frost in fall is in the first half of October.

Detailed data on sunshine and cloudiness are not available for the immediate area concerned, but data from other areas in the same general region suggest that probably about 50 percent of the days of the year are clear, about 30 percent partly cloudy, and 20 percent cloudy.

Detailed figures on relative humidity and rate of evaporation are not available, but it is known that the former is low and the latter very high. At Tribune, some 70 miles farther west, recorded rates of evaporation during the summer range up to more than 16 inches per month.

CASTLE ROCK

Castle Rock is a towerlike mass of Niobrara shale and chalk, about 55 feet in height, located in southeastern Gove county (Fig. 1), in SW $\frac{1}{4}$ sec. 1, T. 14 S., R. 26 W. It occurs about 1 mile south of Hackberry creek, near the head of a broad, pediment-like slope (cf. Frye and Smith, 1942), rising gently from the inner valley of

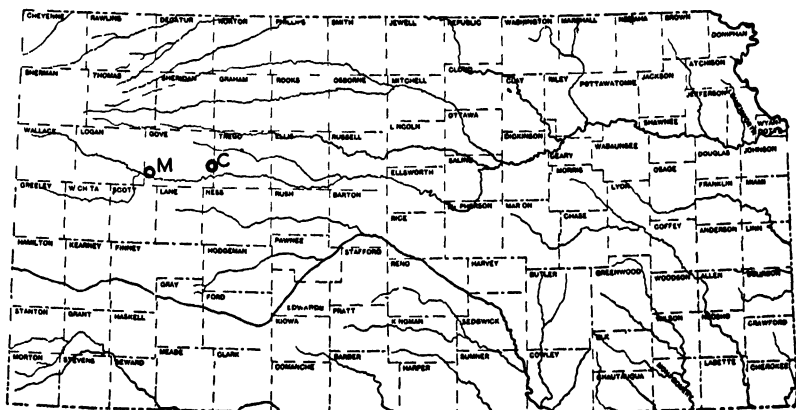


FIG. 1. Location map; C represents the location of Castle Rock, and M the location of Monument Rock.

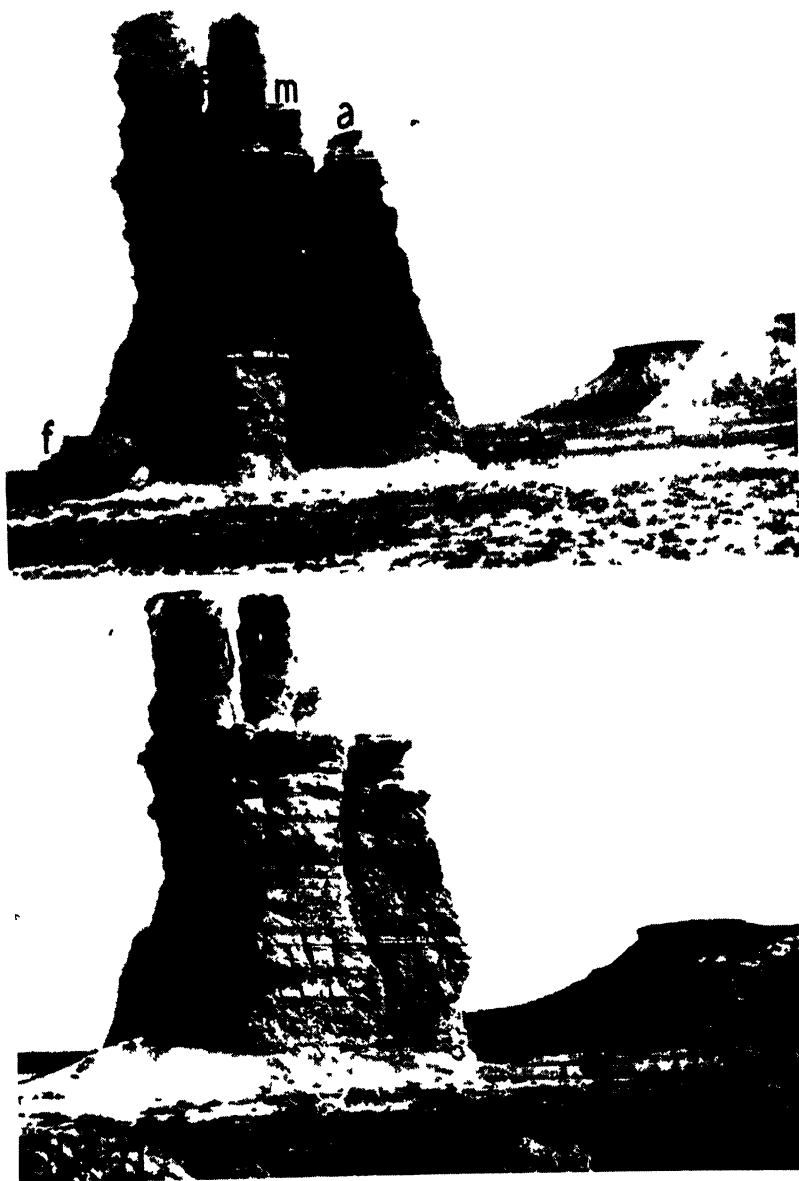


PLATE I Earlier and later views of Castle Rock looking southeast. The upper photo is from Williston (1897). Letters indicate points where conspicuous changes may be observed.

the stream to a low upland flat capped by beds of the Ogallala formation. It represents an erosion residual which chanced to be left isolated as the main slope was pushed back toward the divide.

The lower part of Castle Rock is composed of thin-bedded grayish calcareous shale, and the upper part is made of medium to thick bedded, gray to buff chalk. The lower part is cut by innumerable small cracks, joints, and veinlets. It is probable that the general form of the feature is at least partially controlled by more persistent joints.

Williston, in 1897 (p. 240), commented as follows on Castle Rock:

"Weathering has left the exposed chalk in many places eroded into picturesque objects. The famous Castle Rock, in the valley of the Hackberry about ten miles from its mouth is a lone pyramid several hundred yards from the upland. My first knowledge of the Rock dates from October, 1874, and since that time I have seen but little evidence of erosion. In various places throughout the chalk beds of the Smoky Hill river I have observed marks scratched by myself eighteen years previously that appeared as clear almost as when they were made. The erosion in general is not nearly so rapid as one would think. The smooth, worn surfaces made on the projecting angles of many low cliffs by the buffaloes are still to be seen nearly as smooth as they were twenty years ago."

For purposes of comparing the past and present form of Castle Rock, two photos are available, taken from two different angles. One published by Williston in 1897 (opp. p. 40), and dated 1894, is reproduced here a part of Plate I. Another, shown here in Plate II, was originally published by Hay in 1889 (p. 102), and may be assumed to have been taken at least one year previously. In order to permit detailed comparisons, I rephotographed Castle Rock in 1941 from approximately the same point as those from which the original photos were taken, as nearly as could be determined by inspection. It may be noted, however, that the perspective in my photos is probably not exactly the same as that of the original photos, owing both to differences in the angular field of the cameras used, and to slight differences in camera position and orientation.

On comparing the two sets of photos, certain obvious changes may be observed. The block at *a* has disappeared. The sides have been undercut at *b*, *c*, *g*, and *k*. The crack at *d* and the cleft at *e* have been deepened. The fallen debris at *f* has been reduced. The shoulder at *h* has been lowered, the knob at *i* has been flattened, and the slope at *j* has been worn back. The beds at the horizon of *l* have been more deeply etched. And, finally, the base of the caprock, at

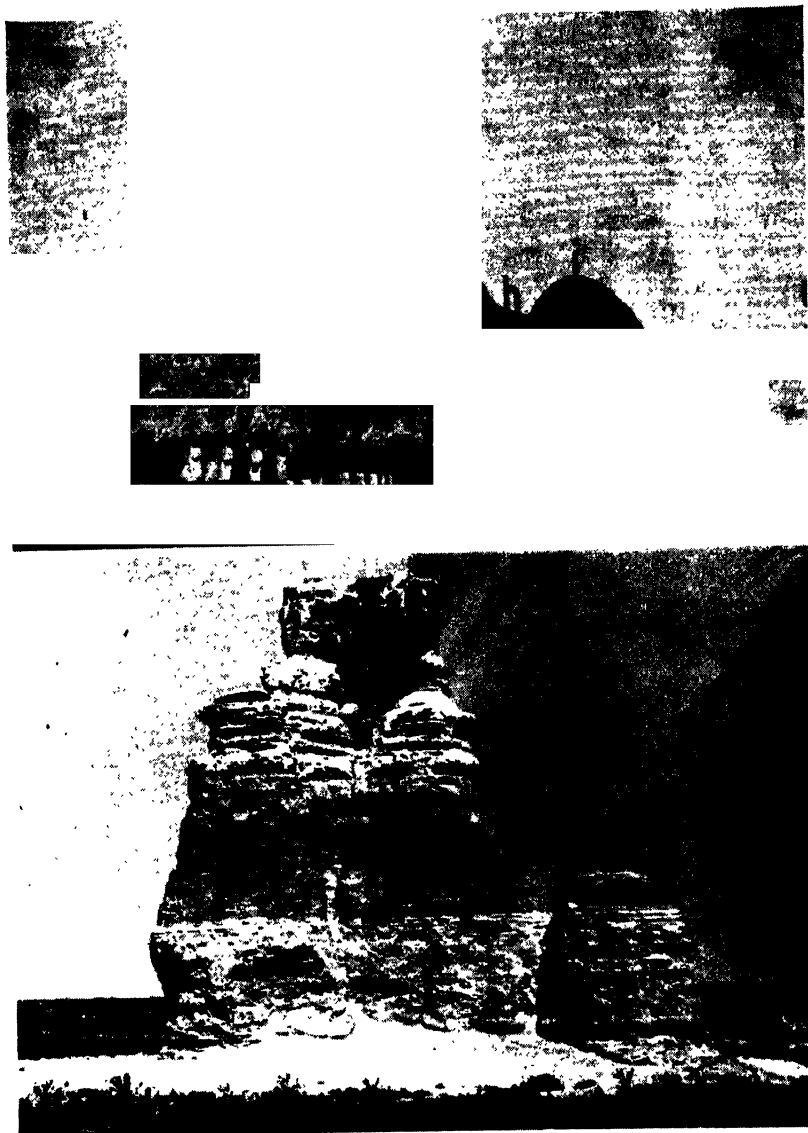


PLATE II. Earlier and later views of Castle Rock, looking north. The upper photo is from Hay (1889). Points which show also in Plate I are indicated by the same letters.

m, has been deeply recessed. Other changes of a minor character could be indicated, but the above suffice to show the general trend.

By superimposing the profiles of Castle Rock as drawn from the earlier and later photos, a rough estimate of the amount of reduction in cross-section area may be obtained. For Plate I, the figure obtained in this way is about 2.5 percent, and for Plate II it is about 6 percent. On the basis of these figures, it would be of interest to attempt an estimate of the total length of time required for the complete reduction of Castle Rock. Direct extrapolation, however, would be erroneous, owing to various complicating factors, of which the following may be mentioned: (1) the rate of reduction is different on different parts of the surface; (2) the rate of reduction is not constant on the same part of the surface—a long period of weathering with little change of form, for example, may pave the way for a sudden slabbing off of large masses of rock with abrupt change in form; (3) a given amount of reduction toward the base affects the reduction of superjacent surface areas by its undermining action, whereas the reduction of the upper slopes has negligible effect on areas beneath; (4) the rate of over-all reduction varies with the ratio of exposed surface area per unit volume of rock, and this ratio may be expected to change as the external form is irregularly modified by erosion. Making due allowance for these factors, however, it may be estimated that a period of time ranging from 500 to 2,000 years will see the total destruction of Castle Rock.

It may be concluded either that Williston underestimated the rate of erosion at Castle Rock, or that the rate has been accelerated since the time of his observations. It should be pointed out, however, that the rock of which Castle Rock is composed is comparatively weak, and that insofar as Williston's other observations refer to more resistant members of the Niobrara formation, there are as yet no grounds for questioning them.

MONUMENT ROCK

The Monument Rocks are a group of castellated erosion residuals located in southwestern Gove county (Fig. 1), along the common boundary line of secs. 33 and 34, T. 14 S., R. 31 W. The southernmost member of this group was photographed by Williston about 1892 (Williston, 1893, opp. p. 108, and 1897, opp. p. 240), and was rephotographed by me in 1941. The two photos are shown together in Plate III. The rock belongs to the Niobrara formation, and is similar to that at Castle Rock, but is less jointed.

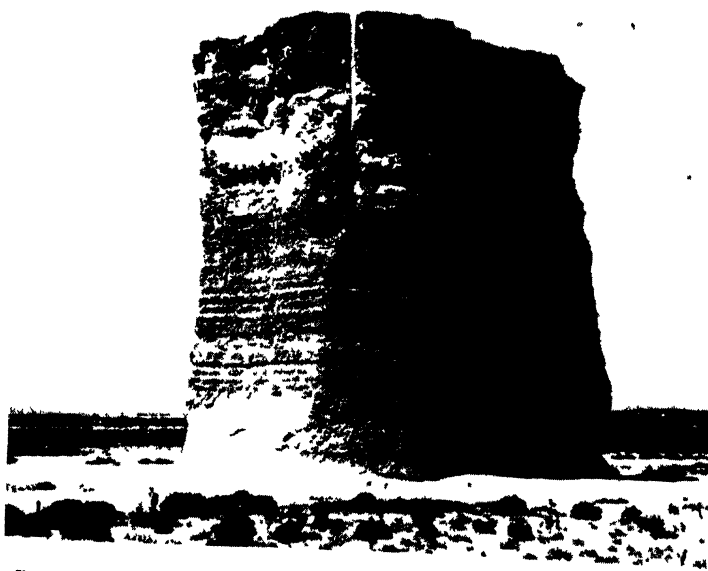
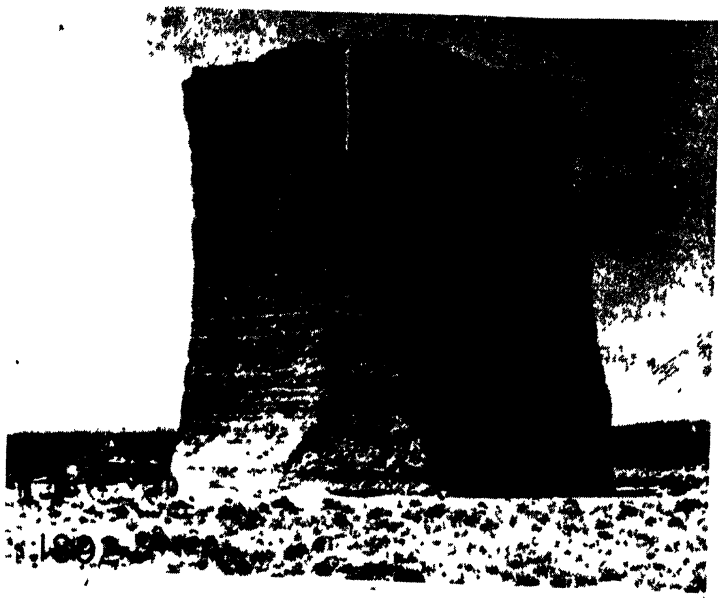


PLATE III Earlier and later views of Monument Rock, looking west The upper photo is from Williston (1893 and 1897)

In 1897 (pp. 240-241), Williston wrote as follows concerning Monument Rock:

"One of the most famous landmarks of the Niobrara is the Monument Rocks on the Smoky Hill River. See Plate XXXV. When I first saw them in 1874 the place had been recently abandoned as the stage station of the Overland stage route. A vertical crack in the main rock has deepened very much since that time and it is now but a question of a few years when it will topple over and be demolished."

A comparison of the photos in Plate III indicates that Williston's prediction was rather ill-advised. The only changes to be seen after some fifty years are a slight deepening of the crack at *a* and slight undercutting at *b* and *c*. The reduction of cross-section area has been only about 0.75 per cent. If the cross-section shown in Plate III were representative of the feature as a whole, and erosion were to continue at the same rate as during the past fifty years, a period of from about 3,000 to 7,000 years would be required for the complete reduction of Monument Rock. Actually, however, the cross-section shown is considerably broader than the one at right angles, and it is probable that the length of time estimated above could be considerably reduced.

EROSIONAL PROCESSES

Rock weathering by disintegration is the basic process effecting the reduction of such forms as Castle Rock and the Monument Rocks. Weathering by solution may play a subordinate part. Small particles are loosened by the wedging action effected by hydration of shale lamina and bentonite seams, and perhaps also by the pressure of growing crystals of secondary derivation in minor cracks and crevices. Expansion and contraction produced by wetting and drying and by diurnal temperature changes are probably significant also. It is doubtful, however, whether frost action plays any appreciable part.

The actual dislodgement of particles is probably facilitated by the beating of rain and hail. Occasionally larger masses of rock are brought down by direct falling or toppling after prolonged undermining and weakening by weathering. One example of this may be seen in the upper photo of Plate 1, and others may be observed today around various members of the Monument Rocks. An additional factor difficult to evaluate is the work of man. Since Castle Rock is a favorite picnic spot, it is conceivable that climbing and hacking by visitors may have augmented the normal processes of reduction.

Problematical also is the part which lightning may have played

in cracking or dislodging rocks. Unconfirmed rumor has it that Castle Rock was so affected on at least one occasion. This, indeed, would provide an acceptable explanation for the disappearance for the seemingly fairly stable knob at *a* on Plate I and II. Ample precedent for this supposition is found in the observations of several writers. Hallock, in 1901, described an actual instance of rock thoroughly shattered by a single stroke of lightning, and Barnett, in 1908, gave details on an occurrence of shattered rock best explained as a result of lightning. Andrée (1934) relates that a large stone block was dislodged from a point near the top of one of the pyramids of Egypt by lightning. More recently, Laudermilk and Kennard (1938) found that rocks could be split experimentally by artificial lightning.

Footing the steep sides of Castle Rock and the Monument Rocks are short slopes of moderate declivity resembling miniature pediments (cf. Bradley, 1940). These foot slopes provide a gradient on which the finer weathered material may be carried outward by rain wash and rill work.

CONCLUSIONS

Weathering and erosion of landforms carved in the Niobrara shale and chalk proceeds at a perceptible rate under the semiarid climatic regime of western Kansas. The rate of change varies in detail according to the lithology and structure of the rock. Within a period of a comparatively few thousand years, however, it is probable that many minor features will be obliterated, and the detailed lineaments of the landscape extensively modified. It is evident, nevertheless, that the carving of the broader features of the landscape—the mesas and the sloping plains—is an exceedingly slow process, to be reckoned in terms of hundreds of thousands or millions of years, if the present rate of erosion is representative of longer spans of geologic time. It is possible, however, that the rate was somewhat greater during the more humid conditions which must have accompanied the glacial stages of the Pleistocene period, and that a disproportionate part of the work of erosion took place under those conditions.

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[No. 2

Mollusca of the Laverne Formation (Lower Pliocene) of Beaver County, Oklahoma

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ABSTRACT: The molluscan fauna of the Laverne formation, lower Pliocene, is described. The mollusks as now known comprise 24 species belonging to 15 genera and 10 families. Eleven of the species are described as new: Amnicolidae—*Calipyrgula hibbardi*, *C. turricula*, *C. tumida*, *C. senta*; Lymnacidac—*Lymnaea laverneensis*; Planorbidae—*Helisoma valens*, *H. goodrichi*, *H. parallelum*; Ancyliidae—*Ferrissia depressus*, *F. angustus*; Pupillidae—*Gastrocopta antirides*. The literature concerning the formation is reviewed. The geology and the problem of the physical conditions prevailing during the deposition of the fossiliferous strata are discussed.

INTRODUCTION

THE name Laverne formation was first applied to sediments exposed in Harper and Beaver counties, Oklahoma, by V. V. Waite in an unpublished manuscript quoted by Gould and Lonsdale (1926). Chaney and Elias (1936) studied the fossil plants of this formation in Beaver county, and proving to their own satisfaction that they were post-Miocene in age, referred to these beds as lower Pliocene deposits, but did not clarify their relationship to the Ogallala formation. Hesse (Chaney and Elias, 1936, pp 47-51) reviewed the literature on the Laverne, and after studying the vertebrate fauna, classified these deposits as a zone in the Ogallala formation. Smith (1940) recognized the presence of rocks which unconformably underlie typical Ogallala beds along the Cimarron river valley in Seward county, Kansas. Frye and Hibbard (1941) described these rocks in Meade and Seward counties, Kansas, and correlated them with the Laverne formation of Oklahoma. The Laverne formation was regarded by them as a distinct formation,

rather than a zone of the Ogallala, for the following reasons: "(1) the unconformity that separates the Laverne from the Ogallala is the greatest break in sedimentation recorded in the Pliocene and Pleistocene section in the Meade basin. The beds of the Laverne dip at angles as great as fifteen degrees and are overlain by horizontal beds of the Ogallala; (2) the lithology of the Laverne is distinct from that of the overlying Ogallala—in fact, on a casual inspection these beds more closely resemble the underlying Cretaceous rocks than they do the Ogallala; and (3) it is a unit that is easily recognizable and mappable in the field." Frye and Hibbard, on the strength of these data and on the basis of the vertebrate fossils contained within the sediments, assign the Laverne formation to the lower Pliocene, but suggest the possibility that the lower part of the formation may be upper Miocene in age.

Dr. John C. Frye, Assistant Director, Kansas Geological Survey, comments (personal communication, 1943) upon the geology of the Laverne formation: "The stratigraphy of the Laverne formation has not yet been adequately studied. Available data indicate that, in general, the lower part of the formation is composed dominantly of sandstone and shale, and the upper part consists largely of shale, silt, chalky limestone, and limestone. Most of the beds seem to be discontinuous and cannot be traced over the entire area, although certain types of lithology are characteristic and persistent. Hard, fine-grained limestone is the most resistant rock type and is prominently exposed along canyon sides; chalky limestone is well exposed in a few places and has been quarried locally for building stone; shale is best exposed where it occurs under ledges of dipping limestone; sandstone is best known from test holes; although the coarse-textured, locally derived channel deposits are well exposed at some localities in Beaver county, Oklahoma. The Laverne formation as studied in Kansas and in Beaver county, Oklahoma, consists of 25 to 40 percent sandstone, 30 to 50 percent shale and silt, and 20 to 30 percent limestone and chalky limestone. The total thickness of the formation probably exceeds 150 feet."

During the summers of 1941 and 1942, the senior author was afforded an opportunity of making a collection of mollusks from exposures of the Laverne formation near Gate, Beaver county, Oklahoma. Not more than a total of a day's time was available for study in the field, but three localities were selected for further study, and from each of them several large grain sacks of the matrix containing molluscan remains were taken. These three collecting

stations, from which were recovered the shells which form the basis of this report, are located south and southwest of Gate, Oklahoma.

Locality 2. Five and a half miles south of Gate, in S. 32, T. 4N, R. 28E, where the Laverne is exposed in a road cut. The beds, which dip strongly at this place, consist largely of grayish-green shale and sandy silt, interbedded with thin strata containing carbonized material and fossilized wood.

Locality 3. Six and a half miles south, one half mile west of Gate, in S. 5, T. 3N, R. 28E. This exposure, along the sides of a dry gulch, consists of reddish-gray, slightly sandy, fine silt overlain with cherty limestone.

Locality 4. Six and a half miles south, two and one-half miles west of Gate, in S. 1, T. 3N, R. 27E, where bluish-gray shale is exposed on the sides of an eroded canyon.

Although at present further field studies are impossible, it seems expedient to make the results of our preliminary study of the Laverne molluscan fauna available to those who may find them of value in stratigraphic and faunal studies in southwestern Kansas, western Oklahoma, and surrounding areas. This molluscan fauna is totally unlike any previous reported from the High Plains Tertiary deposits.

ACKNOWLEDGMENTS

We wish to express our appreciation to Doctor H. H. Lane, Director, and to Doctor C. W. Hibbard, Curator, of the Museum of Vertebrate Paleontology, Kansas University Museum of Natural History, who generously supplied facilities for collecting and studying the molluscan fauna herein reported; to Mr. Calvin Goodrich, Doctor Henry van der Schalie and Doctor Elmer G. Berry, Museum of Zoölogy, the University of Michigan; Mr. Henry A. Pilsbry, the Philadelphia Academy of Natural Sciences; Doctor Stanley T. Brooks, Carnegie Museum, Pittsburgh; Doctor William Clench, Museum of Comparative Zoölogy, Harvard; and to Doctor Paul Bartsch, of the National Museum, for their kind assistance with specific systematic problems.

SYSTEMATIC DESCRIPTION

PELECYPODA

UNIONIDAE (d'Orbigny) Ortmann

Unio sp. (?)

The beds in which Waite (Chaney and Elias, op. cit., p. 50) states that . . . "clam shells are found in abundance," have not been found by us, but near locality 3, a few poorly preserved individuals of some species of fresh-water mussel were found in sandy silt below limestone ledges. One of the better of these shells was submitted to Doctor Henry van der Schalie, of the Museum of Zoölogy, University of Michigan, who commented (personal communications, 1943), "The fresh-water specimen is clearly a mussel, but just where it should be placed is very uncertain. There are practically no characters on which to base a diagnosis . . . to judge from its general appearance . . . it is not an *Anodonta* but more closely related to some of the many forms of so-called *Unio* which are known from these fresh-water deposits of the western plains and foot-hills."

SPHAERIIDAE Dall

Musculium Link*Musculium* sp.; Plate IV, Fig. 3.

A few fragmentary shells, recognizable as belonging to the genus *Musculium*, but too poorly preserved to allow specific determination, were found associated with *Pisidium*.

Pisidium C. Pfeiffer*Pisidium abditum* Haldemann; Plate IV, Fig. 1.*Pisidium noveboracense* Prime; Plate IV, Fig. 2.

These two rather well-defined forms of *Pisidium* were submitted to Doctor Stanley T. Brooks of the Carnegie Museum, who identified them, but commented (personal communication, 1943), "Absolute species are a rarity in the Sphaerids. They are ecological groups today; (*Pisidium*) *abditum* is not a species but the name of the pattern of those belonging to one group. . . . So with *noveboracense*." These species of Sphaeriidae are not numerous in the three localities from which our collections were made, but field observations indicate them to be locally abundant.

GASTROPODA

VIVIPARIDAE (Gray) Gill

Viviparus Montfort

Viviparus sp.; Plate A, Fig. 6.

A few broken shells, identified by Mr. Calvin Goodrich of the Museum of Zoölogy, University of Michigan, are *Viviparus*; however, specific characters are lacking.

AMNICOLIDAE (Tryon) Gill

Calipyrgula Pilsbry

Calipyrgula hibbardi sp. nov.; Plate IV, Fig. 7.

Holotype. Number 980, Molluscan Collection, University of Kansas Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. An amnicolid snail of small size, with 7 strongly convex whorls, wound on the elongate spire typical of the genus. *Calipyrgula hibbardi* differs from *C. ellipsostoma* Pilsbry, to which it seems most closely related, by its larger size, more strongly convex whorls, deeply incised suture, conspicuous vertical striations, and more broadly oval aperture.

Description of holotype. Shell small, subperforate; whorls 7, strongly convex; suture deeply incised; whorls increase gradually in size; shape of shell narrowly conic; apex obtuse; first whorl coiled in single plane; height of spire equal to about one-half of total height of shell; body whorl somewhat inflated; peristome broadly oval; lip thin, simple, and continuous, reflected on parietal wall and over umbilical chink; aperture height equal to one-fourth total height of shell; nuclear whorl smooth; remaining whorls embellished with fine, closely spaced, raised lines; spiral lines below periphery fine, scarcely visible even with magnification.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (980)	4.1 mm	1.6 mm.	1.0 mm.	0.6 mm.	7
Paratype (981)	4.2	1.6	1.3	0.8	7
	3.9	1.4	1.2	0.7	6½
	3.2	1.4	1.1	0.8	6

Paratype series, MZUM 162683.¹

1. All numbers prefixed by MZUM indicate paratype series deposited in the Museum of Zoölogy, the University of Michigan.

Calipyrghula hibbardi is named in honor of Doctor Claude W. Hibbard, Curator of Vertebrate Paleontology, University of Kansas.

Calipyrghula turricula sp. nov.; Plate IV, Fig. 4.

Holotype. Number 982, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 2, five and one-half miles south of Gate, Beaver county, Oklahoma.

Diagnosis. A species with elongate conic shell, small, but among the larger known species of the genus. *Calipyrghula turricula* may be differentiated from *C. hibbardi* by its larger size, larger number of whorls (8), and by its relatively coarse vertical striations.

Description of holotype. Shell small, subperforate, turreted; whorls, 8; apex somewhat obtuse; nuclear whorl slightly projecting; remaining whorls strongly and evenly convex, increasing regularly in size; suture deeply impressed; spire equals scarcely one-half the total height; peristome oval; lip thin, sharp, and continuous, scarcely reflected over the small umbilical chink; aperture slightly less than a third of total height; nuclear whorl unmarked, or but slightly granular; remaining whorls embellished with transverse striations which become coarser as the whorls increase in size, while upon the penultimate and body whorls the striations are fused into irregular corrugations; faint spiral lines present below periphery on body and penultimate whorls; columella a simple spiral column.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (982)	6.6 mm.	2.2 mm.	2.1 mm.	1.1 mm.	8
Paratype (983)	6.5	2.5	2.0	1.4	7
	5.3	2.0	1.6	1.3	7
	4.8	1.8	1.3	1.2	7

Paratype series MZUM 162684.

Spiral lines, scarcely apparent on the shell selected as the type, are lacking on many of our paratypes, and when present, are invariably inconspicuous. The transverse, raised striations vary from numerous fine lines to coarse corrugations, both among individual shells, and upon different parts of the same shell.

Calipyrghula tumida sp. nov.; Plate IV, Fig. 9.

Holotype. Number 984, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 2, five and one-half miles south of Gate, Beaver county, Oklahoma.

Diagnosis. Similar to *Calipyrgula turricula*, but differentiated from it by the obesity of the body whorl, and more broadly conic profile, and by the relatively larger and more elongate aperture.

Description of holotype. Shell small, subperforate, whorls $6\frac{1}{2}$, strongly convex; suture deeply impressed; whorls increase rapidly giving shell a conic shape; apex obtuse; first one and a half whorls coiled in same plane; nucleus projecting slightly; spire occupying about two-fifths of total height; body whorls strongly inflated; diameter approximately one-half total height, peristome oval; lip thin, sharp, continuous, scarcely reflected over the small umbilical chink; aperture height equal to about two-fifths of total height; nuclear whorl smooth; remaining whorls marked with fine, closely spaced transverse striations, which on the body whorl are fused to form faint, irregular ridges; spiral lines poorly developed; columella a simple spiral column.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (984)	5.6 mm.	2.7 mm.	2.1 mm.	1.5 mm.	$6\frac{1}{2}$
Paratype (985)	5.0	2.6	1.8	1.6	6
	4.5	2.3	1.7	1.2	6
	4.1	2.2	1.7	1.1	6

Paratype series MZUM 162685.

Although the relative obesity of the body whorl is a constant feature of this species, there is a greater range of size than is found among other known species of the genus. Vertical striations vary from closely spaced, fine, raised lines to aggregations which form low ridges, especially on the lower whorls. Spiral lines are invariably inconspicuous and frequently wanting.

Calipyrgula senta sp. nov.; Plate IV, Fig. 8.

Holotype. Number 986, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south and one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. In general form, *Calipyrgula senta* is intermediate between the narrow, elongate *C. turricula* and the more broadly conic *C. tumida*. A series of spinous excrescences of variable number, set on a spiral ridge on the periphery, and which may occur on any whorl save the nucleus, and often paralleled below by a low angulate spiral ridge serves to distinguish *C. senta* from both *C. turricula* and *C. tumida*, as well as from other known species of the genus.

Description of holotype. Shell small, subperforate, turreted;

whorls, 7; strongly convex, increasing regularly in size; suture deeply incised; spire occupying two-thirds of total height; diameter of the scarcely inflated body whorl equal to about two-fifths of the total height; peristome oval; lip thin, sharp, continuous, reflected over small umbilical chink; nuclear whorl smooth; remaining whorls marked with fine, closely spaced transverse striations which become heavier on the body whorl; penultimate and body whorls conspicuously embellished with widely spaced, heavy conical spines, united at their bases by a spiral ridge; spines of body whorl paralleled below by a low, angulate ridge; columella a simple spiral column.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (986)	4.8 mm.	2.2 mm.	1.5 mm.	1.2 mm.	7
Paratype (987)	4.7	2.3	1.6	1.2	6½
	4.7	2.2	1.6	1.1	6½
	4.7	2.2	1.6	1.1	6
Paratype series MZUM 162686.					

Mature specimens of *Calipyrghula senta* vary little in contour or dimensions, but the number and distribution of the spinelike excrescences is subject to considerable variation; the spines may appear on all whorls save the nuclear whorls, or they may be limited to the body whorl. On occasional examples the spines are obsolete or completely wanting, although in the latter case, the spiral ridge remains as a constant feature. The larger spines are hollow. The angulation below the periphery in some specimens is well defined, in others not well defined, or entirely absent. The angulation varies from a regular to a wrinkled, contorted ridge.

LYMNAEIDAE Broderip

Lymnaea Lamarck

Lymnaea lavernensis sp. nov.; Plate IV, Fig. 11.

Holotype. Number 988, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 4, six and one-half miles south, two and one-half miles west of Gate, Beaver county, Oklahoma.

Diagnosis. A large, bulimiform species, with short spire and inflated body whorl. The surface is typically embellished with strong vertical raised lines, and often with spiral ridges as well, producing an effect of malleation. *Lymnaea lavernensis* somewhat resembles *L. magister* (Baker) in size and general shape, but differs from that species in the greater proportionate size and degree of inflation of the body whorl, and in the relatively larger aperture.

Description of holotype. Shell large, ovate, inflated, bulimiform, almost imperforate; apex acute, whorls of the spire moderately convex; body whorl large, inflated, occupying about two-thirds of total height; suture shallow, incised; the one and one-half nuclear whorls elevated, uniformly and finely granular; remaining surface vertically striate; striae fine and numerous on upper whorls of spire, becoming coarser toward the body whorl upon which they form corrugations; rather coarse, parallel spiral ridges crossing the vertical striations produce an effect of malleation upon the fifth and sixth, and first half of body whorl. Aperture elongate oval, height exceeding half the total height of shell; aperture about half as wide as high; peristome thin, simple, continuous; broadly reflected over the umbilical chink.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (988)	34.6 mm.	19.8 mm.	18.5 mm.	9.6 mm.	7
Paratype (989)	39.7	22.5	24.8	11.9	7
	31.6	18.9	17.2	10.0	6
	28.1	15.8	16.6	8.6	6½
	21.4	12.6	12.6	6.0	6
Paratype series MZUM 162687.					

This large *Lymnaea*, named from the Laverne formation, forms a characteristic and conspicuous feature of the fossil remains contained in these deposits. The species is found in deposits of silt, limestone, and shale, and so far as now known, ranges throughout a great part of the total beds of the formation. The bearing this fact may have on the ecological tolerance of this species has not been adequately studied.

So far as known, *Lymnaea magister* (Baker), which appears somewhat closely related to *L. lavernensis*, is restricted in its distribution to Tule Lake, Modoc county, California (Baker, 1934). The geographical remoteness, as well as the separation in time, makes it difficult to determine whether the similarities in the appearance of *L. lavernensis* and *L. magister* are genetic or fortuitous.

The apparent wide extremes in size among examples of *Lymnaea lavernensis* are due largely to differences in degree of maturity. The surface sculpture of the shells of this species consists of vertical striations composed of fine, closely spaced, raised lines, or of more widely spaced, heavier ridges which give the surface a ribbed appearance. An effect of malleation is produced on some shells by heavy spiral ridges which intersect those extending vertically. The whorls of the spire are usually of no more than moderate convexity and separated by a shallow suture, but in certain examples, the suture is more deeply impressed, and the whorls strongly shouldered.

Pseudosuccinea F. C. Baker

Pseudosuccinea columella (Say) ; Plate IV, Fig. 12.

A large series of *Pseudosuccinea* from the Laverne formation compares well with typical *P. columella* except for being somewhat smaller. It is not possible to say whether the Laverne *Pseudosuccinea* is a small race of *columella*, or whether the larger specimens have not been recovered because of their fragility. The transverse striations are typically developed, but the heavy, indented spiral lines mentioned by Baker (1911, p. 166), are very faint or entirely absent.

Pseudosuccinea is well represented in a number of localities where the Laverne formation is exposed, and in certain places it is the predominating species.

PLANORBIDAE H. A. Adams

Helisoma Swainson

Helisoma antrosum (Conrad) ; Plate V, Fig. 23.

This species is found in considerable numbers in various deposits in the Laverne formation. It is by far the most numerous of the planorbid snail remains and in actual numbers is rivaled only by the various species of *Calipyrghula*. In form and sculpture the examples studied are quite typical of the shells of living *Helisoma antrosum*, but average somewhat smaller, the largest individuals attaining a diameter of scarcely 8.0 mm.

Helisoma valens sp. nov. ; Plate V, Fig. 24.

Holotype. Number 992, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 4, six and one-half miles south, two and one-half miles west of Gate, Beaver county, Oklahoma.

Diagnosis. A helicoid snail of $4\frac{1}{2}$ whorls, approximating *Helisoma antrosum* (Conrad) in size, but differing from that species in several respects: the spire is less depressed; the whorls are convex, rather than carinate; the umbilicus is deeply and narrowly depressed; the sculpture is less conspicuous and the shell is heavier.

Description of holotype. Shell strong, of moderate size, ultra-sinistral, whorls $4\frac{1}{2}$, increasing rapidly in size; spire somewhat depressed; all whorls visible above; nuclear whorl rounded, granular; remaining whorls convex; periphery rounded; umbilical deeply depressed, narrow; nuclear whorl partially concealed; surface sculptured with rather fine, obliquely transverse striations, somewhat

coarser below; aperture subtriangular somewhat expended, its width greater than axial height of shell; peristome simple, thickened; terminations approaching and connected across parietal wall with a heavy callus; two rest periods indicated by heavy scars.

	Greater diameter	Lesser diameter	Axial height	Width of peristome	Height of peristome	No. of whorls
Type (992)	10.0 mm.	7.6 mm.	4.3 mm.	5.3 mm.-	3.3 mm	4½
Paratype (993)	7.3	5.6	3.4	4.3	2.2	4

Helisoma valens is quite unlike any other planorbid from the Laverne formation or from the overlying Pleistocene deposits, and does not appear closely related to *H. trivolvis*, the only representative of the genus living in the region today.

Unlike the other planorbids of the Laverne deposits which are represented by adequate series of specimens, *H. valens* is known only from the type and a single paratype.

Helisoma goodrichi sp. nov.; Plate V, Fig. 22.

Holotype. Number 994, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. A small species, bearing the characters of the *Pierosoma* group of *Helisoma*. The 4 whorls are subangulate above, convex below, except the nucleus, which is flattened. There is some resemblance to immature examples of *H. carribaeum* (d'Orbigny).

Holotype. Shell small, ultrasinistral, whorls 4, increasing regularly from the nuclear whorl to the aperture; spire depressed; cavity of the spire broadly open exhibiting the convexity of all whorls; nuclear whorl almost flat; remaining whorls subangulate above, convex below, periphery rounded; umbilical cavity not as deeply depressed as cavity of spire, broadly open exhibiting all whorls except nuclear whorl which is partly concealed; surface sculptured with fine, transverse, closely spaced striations, bent obliquely backward on base and becoming coarser on last half of body whorl; aperture high, lunate; peristome thin, simple, subangulate above, rounded at the periphery and straightened below; terminations reflected on parietal wall, approaching but not continuous.

	Greater diameter	Lesser diameter	Axial height	Number of whorls
Type (994)	4.3 mm.	3.6 mm.	2.0 mm.	4
Paratype (995)	4.5	3.8	2.0	3¾
	4.1	3.5	2.0	3¾
	4.0	3.4	1.9	3½
	3.7	2.8	1.9	3¾

Paratype series MZUM 162688.

This small species of *Helisoma* does not resemble any other planorbid known from the High Plains area. Mr. Calvin Goodrich, who examined a series, (personal communication, 1943) suggested a possible relationship with *H. carribaeum* (d'Orbigny). Even on the assumption that our collection is composed entirely of immature shells, which to us seems unlikely, the relationship to *H. carribaeum* seems obscure. The angular contour of the aperture and the depressed, almost funicular cavity above the spire in *H. goodrichi* add credence to our view.

Helisoma goodrichi occurs in deposits with *H. antrosum* Conrad, to which it does not seem closely related, but in much smaller numbers.

Helisoma goodrichi is named in honor of Mr. Calvin Goodrich of the Museum of Zoölogy, University of Michigan.

Helisoma parallelum sp. nov.; Plate V, Fig. 16.

Holotype. Number 996, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. A minute species, similar in certain respects to *Helisoma goodrichi*, but its distinctive surface sculpture of parallel raised lines, the lack of carination of the whorls, and the strong callus which connects the terminations of the peristome across the parietal wall, differentiates *H. parallelum* from *H. goodrichi*.

Description of Holotype. Shell small, ultrasinistral; whorls, 3 (shell apparently immature), tightly coiled, increasing regularly from the nuclear whorl to the aperture; spire depressed, cavity of the spire exhibiting all the volutions; nuclear whorl almost flat; remaining whorls convex, periphery rounded; umbilical cavity not as deeply depressed as cavity of spire, broadly open, exhibiting all the whorls; surface covered with fine, transverse, closely spaced striations, bent obliquely backward on the base, with parallel, raised, spiral lines superimposed upon them; aperture high, rhomboidal, of same width as body whorl; peristome thin, simple, ends approaching and connected across the parietal wall by a conspicuous callus.

	Greater diameter	Lesser diameter	Axial height	Number of whorls
Type (996)	2.1 mm.	1.8 mm.	1.0 mm.	3+
Paratype (997)	2.1	1.6	1.0	3
	1.9	1.5	0.9	2¾
	1.5	1.3	0.8	2½

Helisoma parallelum was recovered from deposits containing *H. antrosum* (Conrad) and *H. goodrichi*. The species is now known only from the type and the three paratypes, all of which are obviously immature.

Gyraulus sp.; Plate IV, Fig. 5.

A broken shell bearing the obvious characters of the genus, but damaged so as to make specific determination impossible, together with a few very immature shells constitute the only evidence of *Gyraulus* thus far discovered in the Laverne deposits.

ANCYLIDAE Menke

Ferrissia Walker

Ferrissia depressus sp. nov.; Plate V, Fig. 19.

Holotype. Number 1005, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. A small depressed patelliform, obovate, very thin and fragile shell. Its small size, depressed spire, and fragile shell differentiate *Ferrissia depressus* from other known North American species of the genus.

Description of the Holotype. Shell small, thin, very fragile, patelliform, depressed, obovate, slightly wider anteriorly; lateral margins convex, anterior and posterior margins regularly rounded; anterior slope slightly convex, lateral slopes concave, especially posteriorly, posterior slope concave; nucleus heavy, its outline apparent; apex scarcely elevated, rounded, deflected slightly toward the right, and located about one-third of the length of the shell from the posterior end; apex radially striate, striations almost obsolete on remainder of shell; concentric growth lines very fine; surface of shell glossy.

	Length	Diameter	Height
Type (1005)	2.9 mm.	1.9 mm.	0.7 mm.
Paratype (1006)	2.2	1.5	0.5
	2.2	1.4	0.4

The two paratypes, although immature and somewhat smaller than the type, otherwise bear the characters of the type with little or no variation.

Ferrissia angustus sp. nov.; Plate V, Fig. 20, 21.

Holotype. Number 999, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. A small species with laterally compressed, nearly parallel sides, and relatively high spire. *Ferrissia angustus* is distinguished from *F. depressus* by its narrower outline, parallel rather than convex side, and higher spire. Its small size, narrowness, and relative height differentiate *F. angustus* from other known North American species of the genus.

Description of the holotype. Shell small, thin, fragile, patelliform, elevated, narrow, elongated, wider anteriorly; lateral margins almost parallel, the left nearly straight, the right curving medially posteriorly; anterior margin evenly rounded; posterior margin asymmetrically rounded, deflected toward the left; anterior slope rounded, right slope straight, posterior slope slightly concave, left slope convex anteriorly, slightly concave posteriorly; apex scarcely elevated, rounded, slightly deflected toward the right, and about a third of the length of the shell from the posterior end. Apex radially striate, striations faintly visible over remainder of shell; concentric growth lines very fine, giving the surface a silky texture.

	Length	Diameter	Height
Type (999)	2.9 mm.	1.5 mm.	0.9 mm.
Paratype (1007)	2.9	1.5	1.1
	2.9	1.8	0.9
	2.7	1.5	0.8

The shells of *Ferrissia angustus* vary in several respects. The lateral margins are straight and almost parallel to slightly rounded; the posterior margin is symmetrically or asymmetrically rounded; the radial striations vary from distinct to scarcely visible markings; on some shells the concentric growth lines are very fine and closely spaced while on others they are somewhat heavier. In a few examples the peristome is reinforced within by a parallel callus growth, somewhat removed from the margin.

PHYSIDAE Dall

Physa Haldemann

Physa hawni Lea; Plate IV, Fig. 10.

Our collections contain only a few immature shells identified by Dr. William Clench, Harvard Museum of Comparative Zoölogy.

ZONITIDAE Pfeiffer

Hawaii Gude

Hawaii miniscula (Binney); Plate V, Fig. 15.

Three shells are assigned to this species. The fossils are identical, except for their smaller size, with typical *Hawaii miniscula* (Binney) which lives in the area today.

PUPILLIDAE Turton

Gastrocopta Wollaston

Gastrocopta anterides sp. nov.; Plate V, Fig. 17.

Holotype. Number 1002, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. *Gastrocopta anterides* is a small, ovate species, the shell composed of 5 moderately convex whorls. The anguloparietal lamella extends from the outer margin of the peristome to the throat of the aperture where it ends in a pyramidal buttress. The columellar lamella is horizontally compressed, and turned down within; the basal is missing or at most weakly developed; lower palatal and upper palatal folds set on a callus not deeply immersed. This combination of characters distinguishes *G. anterides* from other known species of the genus and leaves its relationships enigmatical.

Description of holotype. Shell small, perforate, conic-ovate in form; whorls 5, moderately convex, increasing regularly in size, except the last which is compressed around the axis; suture sharply incised, but not deep; aperture obliquely oblong; peristome thin, sharp, margins approaching and connected across parietal wall by thin callus; the one and one-half nuclear whorls nonstriated, granular; remaining whorls marked with fine, closely spaced, oblique striations; denticles 5: the angular projecting as a small spur from the well fused anguloparietal, the tooth extending from the inner margin of the angular lip of the peristome to a point opposite the columellar lamella, terminating in a strong pyramidal buttress; columellar lamella well developed, horizontally compressed around the axis, its inner termination turned downward; basal fold feebly developed; lower palatal dentiform, somewhat laterally compressed, diminishing as it extends inward; upper palatal fold nodose, weakly developed; palatal folds set on a callus which bears faint suggestions

of two interpalatal plicae; the callus appears also as a low external ridge.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (1002)	2.9 mm.	1.9 mm.	1.08 mm.	0.99 mm.	5.0

The two paratypes of *Gastrocopta anterides*, except for a few slight variations in the development of the denticles, are identical with the type. The anguloparietal and the columellar lamellae are invariable, but in the one specimen the basal fold is feebly developed, as in the type, in the other nodose. The interpalatal folds are missing in one example, although the callus between the upper and lower palatals is persistent; in this specimen there is an indentation of the angular portion of the peristome suggestive of the angle so characteristic of *Vertigo*.

Gastrocopta riograndensis Sterki; Plate V, Fig. 14.

A small series of shells, although varying in minor details, is referred to *Gastrocopta riograndensis* Sterki. This species has not been found living in the region today and it has not been recovered from local Pleistocene deposits.

Vertigo Draparnaud

Vertigo ovata Say; Plate V, Fig. 13.

These shells, represented in our collections by a small series, compare favorably with typical *Vertigo ovata* Say. This snail is common in local Pleistocene deposits, but the genus is not represented among the living species of this area.

Pupoides Pfeiffer

Pupoides marginatus (Say); Plate V, Fig. 18.

A single specimen which compares favorably with the forms recovered from near-by Pleistocene deposits constitutes the only record of this species from the Laverne formation.

The type of gastropod life one should find associated with flood plain forest as postulated by Chaney and Elias (op. cit. pp. 25-34) is not in evidence from the collections thus far made. These five species mentioned above, none of which are found in an aquatic environment, constitute the only indication of a terrestrial gastropod fauna. All are represented by a small series and all are small enough to float long distances; that is to say, their presence does not necessarily point to near-by shores.

DISCUSSION

A conspicuous feature of the Laverne formation is a zone of diatomaceous marl which has been studied in Seward county, Kansas, by Frye and Hibbard (1941, pp. 402-403) and in Beaver county, Oklahoma, by Chaney and Elias (op. cit., pp. 14-15). Thirty-seven species and varieties of diatoms are known from the Beaver county deposits, of which 12 percent occur among the 34 species and varieties known from the Seward county marls. According to Doctor K. E. Lohman (Frye and Hibbard, op. cit., p. 403) the diatom flora of Seward county ". . . contains a large number of species that live in saline waters at the present time and their occurrence in the beds in Seward county suggests very strongly that they were deposited under similar conditions." Below the diatomaceous marl an ostracod species, *Cyprideis littoralis* (Brady), is present in large numbers. Doctor Willis L. Tressler, of the University of Maryland, who identified the ostracod shields, commented (Frye and Hibbard, op. cit., p. 401): "This form is a species which occurs at the present time in brackish lakes, particularly along the margins." Thus it seems well established that the sediments comprising the diatomaceous marls were deposited under brackish water conditions.

In spite of the present inadequate knowledge of the stratigraphy of the Laverne formation, it seems fairly certain that the fossiliferous zones from which our molluscan collections were made, occur above the diatomaceous marl. Following the same line of thought as that applied to the diatoms and ostracods, and applying it to an interpretation of the molluscan fauna, it seems apparent that ecological conditions in the ancient Laverne basin underwent a change following the deposition of the diatomaceous marl, and that the mollusks lived, not under brackish, but under fresh-water conditions.

The four molluscan species which are present in greatest numbers in the Laverne sediments are *Helisoma antrosom* (Conrad), *Calipyrgula turricula*, *Pseudosuccinea columella* (Say), and *Lymnaea lavernensis*. The success of the species apparently indicates fresh-water streams or freshwater ponds. According to Baker (1928, p. 319) *Helisoma antrosom* is ". . . primarily a river and creek species, not living in the large lakes. . . . In the Wisconsin river it lives along shore and shallow water on debris of various kinds." Although the genus *Calipyrgula* Pilsbry has no known living species, it seems probable that its Laverne representatives lived in quiet, fresh water. Pilsbry (1934, p. 542), in attempting to reconstruct the conditions under which the Kettleman Hills fauna lived, says,

"The great number of shells of some Amnicolidae indicate an abundant aquatic flora, as these snails are most copiously developed when there are masses of filamentous algae and leafy water plants on the bottom. Such growths do not occur in deep water." The same argument seems applicable to the great numbers of *Calipyrgula* in the Laverne, which indicates that they probably lived in shallow, ponded, waters. This argument is substantiated by the presence in the deposits of zygote capsules of some species of *Chara*, as yet not identified. *Pseudosuccinea columella* (Say) "Is an inhabitant of ponds and streams where the water is more or less stagnant; a locality with an abundance of lily pads is particularly favorable; it is found also along the shores in shallow water in the vicinity of cat-tails (*Typha*) and other reeds. . . . Rarely found in running water" (Baker, op. cit. p. 276). *Lymnaea lavernensis*, so far as known an extinct species, is found throughout a wide vertical range in the Laverne sediments above the marl, which may indicate extreme ecological tolerance, but the known facts about the large living species of *Lymnaea* indicate that this species was probably an inhabitant of freshwater streams or ponds.

The remaining aquatic molluscan species, none of which are well represented numerically in the deposits, were likewise inhabitants of freshwater streams or ponds, and without an especial tolerance for brackish-water conditions, if one may judge from the behavior of their living representatives or relatives.

Associated with molluscan fauna were found fish scales, fish vertebrae, and other small bones, identified by Doctor Claude W. Hibbard, Curator of the Museum of Paleontology, University of Kansas, as the remains of gar, other teleost fish, and amphibians, respectively. Even though this fragmentary material does not permit specific identification, it does serve as additional evidence toward the building up of a picture of freshwater conditions during the time the Laverne molluscan fauna was living. The beavers are indicative of the presence of permanent streams, although not confined to them, as pointed out by Hesse (Chaney and Elias, op. cit., p. 70). Chaney and Elias (idem., p. 16) also report among the Laverne flora, the cat-tail, (*Typha*) which is not known to live in brackish water.

These authors, with regard to physical conditions indicated by the Beaver county fossil flora, suggest that the trees constituted a flood plain forest (idem. pp. 25-34) similar to that which exists along the streams in eastern Oklahoma today; in fact they conclude from their observations that the minimum annual rainfall was in excess

of 30 inches. According to their interpretation of the flora, the absence of evergreen oaks indicates that the rainfall was concentrated during the warmer months as is the case in Oklahoma at the present time. The average temperature was considered by them to have been somewhat higher than it is in western Oklahoma today.

On the other hand, the presence of spines on the shell of *Calipygula senta* may indicate brackish water conditions in the Laverne after the deposition of the marl, at least locally. It has been shown by Boycott (1929) that *Hyrobia jenkinsi* Smith when living in fresh water is devoid of spines, but when this snail is placed in brackish water, its offspring develop spiney excrescences. Doctor Henry van der Schalie, Assistant Curator, Division of Mollusca, Museum of Zoölogy, University of Michigan (personal communication, 1943) observed in Puerto Rico that *Potamopyrgus coronatus* Pfeiffer, which is embellished with a series of compressed spines, often inhabits brackish water. Aguayo (1938) mentions *Potamopyrgus* as an inhabitant of brackish estuaries in Cuba, although he does not comment on the spines in relation to habitat. From available data it seems that there may be a correlation between brackish-water environments and the appearance of spines on the shells of snails. The data indicating fresh-water conditions and those which indicate the possibility of brackish-water environments need not necessarily be viewed as mutually contradictory. It was the opinion of Waite (Chaney and Elias, op. cit. p. 50) “. . . that the formation represents a series of small lakes, perhaps similar to the present lakes in northern Indiana. This suggestion is tentatively made for the reason that the formation is scattered and has a variation in lithologic character even though the outcrops are only a short distance apart. The fauna, too, indicates small separate bodies of water. For instance, at one locality, clam shells are found in abundance and not in others. In one locality, fossils were much larger than in others. At another place, a great number of leaves were found. A two-inch seam of peat was found at still another place. These facts would indicate small bodies of water either isolated or connected in which the conditions in one place were different in another and thus the cause for variety of fossils both in size and species.”

Chaney and Elias, while not fully in accord with Waite's interpretation, agree that his concept of the physical conditions during the deposition of the Laverne sediments is in the main correct.

A similar concept of conditions prevailing during early Pliocene

times is held by Doctor John C. Frye (personal communication, 1943), who accounts for the presence of saline water by an interesting hypothesis:

"Deposits constituting the Laverne formation were deposited in channels, on flood plains, and in discontinuous or partly connected lakes. . . . The lithology of the chalky limestone and the contained diatoms and ostracodes (Frye and Hibbard, *op. cit.*, pp. 401-403) indicate that the lakes in which these deposits accumulated contained brackish water. This seems to imply a semiarid to arid climate for this region during early Pliocene time. It is possible, however, that the brackish water condition in these lakes was caused by upward migration of brines from the Permian salt beds underlying the area. This hypothesis is given some credence by the fact that throughout most of this area the Laverne strata are folded, and dips of as much as 15 degrees have been measured. If this folding was in part due to solutional phenomena or if the lakes in which these sediments were trapped were formed by deep-seated solution of a type similar to that which occurred during the Pleistocene, (John C. Frye and Stuart L. Schoff, 1942, pp. 35-39) it is quite possible that some brine might have migrated upward and contaminated fresh-water lakes. The thick section of sandstone seems to imply that a relatively large volume of water moved across this area, which could hardly be possible if the climate were arid enough to cause brackish-water conditions in lakes."

In the light of these data and concepts, it is our opinion that conditions during the deposition of the Laverne sediments were characterized by a large shallow lake, or more probably, a series of small lakes or ponds in a large basinal area and fed by fresh-water streams. It seems obvious to us that these lakes or ponds became less saline following the period of the diatomaceous limestone. This change can be accounted for either by an increase in humidity or by assuming stoppage of the fissures through which saline waters may have risen from below, if one accepts Frye's hypothesis. As a matter of fact, there is little lithological evidence which would support an hypothesis of increased humidity following the period of the deposition of the diatomaceous marl.

The problems of the physical conditions during the deposition of the Laverne molluscan fauna are still largely unsolved, and must await an opportunity for intensive studies in this area.

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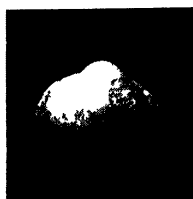
PLATE IV

- FIG. 1. *Pisidium noveboracense* Prime
Catalogue number 978
- FIG. 2. *Pisidium abditum* Haldemann
Catalogue number 977
- FIG. 3. *Musculium* sp.
Catalogue number 976
- FIG. 4. *Calipyrghula turricula* sp. nov.
Holotype
Catalogue number 982
- FIG. 5. *Gyraulius* sp.
Catalogue number 998
- FIG. 6. *Viviparus* sp.
Catalogue number 979
- FIG. 7. *Calipyrghula hibbardi*
Holotype
Catalogue number 980
- FIG. 8. *Calipyrghula senta* sp. nov.
Holotype
Catalogue number 986
- FIG. 9. *Calipyrghula tumida*
Holotype
Catalogue number 984
- FIG. 10. *Physa hawni* Lea
Catalogue number 1000
- FIG. 11. *Lymnaea lavernensis* sp. nov.
Holotype
Catalogue number 988
- FIG. 12. *Pseudosuccinea columella* (Say)
Catalogue number 990

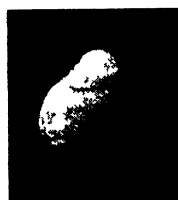
PLATE IV



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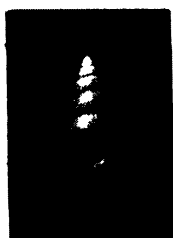
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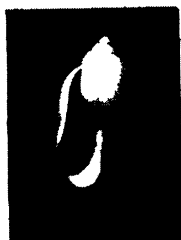
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PLATE V

- FIG. 13. *Vertigo ovata* Say
Catalogue number 1004
- FIG. 14. *Gastrocopta riograndensis* Sterki
Catalogue number 1003
- FIG. 15. *Hawaiiia miniscula* (Binney)
Catalogue number 1001
- FIG. 16. *Helisoma parallelum* sp. nov.
Holotype
Catalogue number 996
- FIG. 17. *Gastrocopta anterides* sp. nov.
Holotype
Catalogue number 1002
- FIG. 18. *Pupoides marginatus* (Say)
Catalogue number 1009
- FIG. 19. *Ferrissia depressus* sp. nov.
Holotype
Catalogue number 1005
- FIG. 20. *Ferrissia angustus* sp. nov.
Holotype
Catalogue number 999
- FIG. 21. *Ferrissia angustus* sp. nov.
Holotype
Catalogue number 999
- FIG. 22. *Helisoma goodrichi* sp. nov.
Holotype
Catalogue number 994
- FIG. 23. *Helisoma antrosum* (Conrad)
Catalogue number 991
- FIG. 24. *Helisoma valens* sp. nov.
Holotype
Catalogue number 992

PLATE V



13



14



15



16



17



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23



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THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

VOL. XXX, pt. I]

MAY 15, 1944

[No. 3

A New Genus and Species of Mexican Hyloid Frogs

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ABSTRACT: A new genus of hyloid frogs, *Ptychohyla*, is described, characterized by a ventrolateral gland of large extent, and a reduced number of nuptial spinules. The genotype, *Ptychohyla adipoventris*, is from Agua del Obispo, Guerrero, México.

A SMALL hyloid frog from the lower parts of the Sierra Madre del Sur of Guerrero, México, differs from other known hyloids in the presence of a lateroventral gland of large extent. This character, together with that of the nuptial spines, cause me to set it under this new genus herein described.

Genus *PTYCHOHYLA* novum

Small hyloid frogs having a large ventrolateral gland; dorsal skin not obviously glandular. In male, the rugosities of the nuptial callosities (horny spines), which are confined to the first finger, are relatively large, reduced in number and covering a smaller area than in other hyloid genera.

Genotype: *Ptychohyla adipoventris* Taylor.

Ptychohyla adipoventris sp. nov.

Hyla erythromma Taylor, Univ. Kansas Sci. Bull., 26, No. 15, 1939 (Nov. 27, 1940), pp. 511, 512 (nec *Hyla erythromma* Taylor 1937).

Type. EHT-HMS No. 21592, collected at Agua del Obispo, Guerrero, México, Aug. 31, 1939, by E. H. Taylor.

Paratypes. EHT-HMS Nos. 21589-21591, 21593-21594, 26834, 28722. Topotypes, same collector; U. S. Nat. Mus. No. 114551, H. M. Smith, Coll.

Diagnosis. A small tree frog, known maximum size, 31.5 mm.,

having a broad, adipose (?) gland extending from near axilla to near groin, and from low on the sides to one-fourth to one-third way across abdomen; vocal sac present in males; 20-50 horny nuptial spines on back and side of first finger, dark brown in color, and not closely spaced; none on other fingers; outer fingers about one-third webbed, toes about four-fifths webbed; distal subarticular tubercle of fourth finger double; tympanum moderately distinct, its diameter about one-half eye diameter; no distinct tarsal fold.

Description of the type. A small frog, the snout very short, high, rather abruptly truncate; nostrils very near anterior point of snout; eye diameter (3.3 mm.) about equal to length of snout (3.55 mm.); diameter of tympanum (1.7 mm.) equal half diameter of eye; width of an eyelid (2.2 mm.) very much narrower than interorbital distance (3.5 mm.); canthus well defined; loreal region concave, the sides of lores nearly vertical, then sloping more obliquely to edge of lip; regions about nostrils swollen prominently, with a depression between; tympanum separated from eye by a distance equal to its own diameter; a straight diagonal fold covers upper part of tympanum.

Tongue flat, thin, somewhat papillate, nearly as broad as long, slightly ($\frac{1}{8}$) free behind and slightly emarginate; choanae very large; the prevomerine teeth in irregular transverse groups separated from choanae and from each other by nearly equal distances; openings of palatal glands form a transverse groove, the ends of which turn back anterior to choanae, lying much nearer to premaxillaries than to choanae; openings of the eustachian tubes less than half size of choanae.

Terminal digital disks of outer fingers larger than the tympanum; three outer fingers about one-third webbed, the web between first and second less; large median palmar tubercle low, somewhat tripartite; inner tubercle flat, more elongate; subarticular tubercles small, that on fourth finger double, on third finger bifid; supernumerary tubercles on hand rather indistinct; a fold or ridge on underside of forearm; about sixty horny tubercles on dorsal and posterior sides of first finger; tibiotarsal articulation to anterior edge of eye or a little beyond; no distinct tarsal fold; dilation of the tips of the toes equal to those of fingers; toes three-fourths to four-fifths webbed, the web reaching only as high as the subarticular tubercle on inner side of second and third toes; a large inner metatarsal tubercle, a small outer tubercle more distal than inner; supernumerary tubercles obsolete.

Skin appearing smooth, but under lens dorsal part of head, back and upper part of sides minutely corrugated; a few indistinct pustules on side; surface of large gland covered with minute tubercles or corrugations; chin and throat smooth; breast less so; an indistinct and incomplete breast fold; median and posterior part of abdomen granular; most of ventral surface of femur granular; anal flap broad, followed by a deep vertical groove, the sides of which are glandular.

Measurements in mm. Snout to vent, 30; width of head, 11; length of head, 10.2; arm, 18; leg, 47; tibia, 15.5; foot, 20.

Color. In life, dark green or greenish-olive, almost uniform in color on the head, back and the upper part of the sides; lower part of sides oily yellow, with numerous small brown or greenish-brown spots sometimes forming short vertical bars; on the venter the gland continues a third way across abdomen on each side, but the dark spots are now minute flecks; middle of abdomen yellowish-white; chin and throat, canary yellow; undersides of thighs and tibia, flesh color; underside of tarsus and foot, purplish; underside of arm and inner toes, whitish-yellow; area about arm insertion, yellow white; upper lip with a few irregular yellowish areas; faint traces of darker areas on back and hind leg, when specimen is submerged in water.

Variation. The variation in the size of the gland seems to be an age character; in a young specimen it is wholly lateral, not reaching the ventral surface; in old males it is thickened more and is of greater extent. The gland itself consists of closely packed, bottle-shaped glandules four or five times as long as their transverse diameter; when squeezed, an oily substance is exuded.

Color variation. Of the paratypes, Nos. 12594 and 28722 resemble the type very closely in coloration. The last mentioned is a young female and the area occupied by the gland is less, and nearly half the abdomen is free of the gland and is areolate. In this the yellowish-white areas on the lips are more sharply defined. There is a large light spot beginning below the tympanum and running forward and upward so as to include part of the lower eyelid. This light spot encloses a brown spot. The remainder of lip is more yellow than green and shows three spots on each side. One specimen has the upper lip edge almost uniform yellow. In the groin behind the gland there is often a dark-bordered, whitish spot present. In two specimens, the largest male, No. 21590, and a medium sized female, No. 21591, dark spots were visible through the lighter green color and irregular bars were evident on the legs and arms. Eyes reddish.

(In alcohol the olive and green has become brownish, or, in the case of the lighter green specimens, lavender.)

Remarks. The frogs were calling, but the distinctive character of the calls could not be ascertained due to the noise of water falling into the pool, over which was spread a glossy leafed shrub, near the water, on which the specimens were perched. They were not especially wary and those seen were taken with ease; other calls were heard higher in trees but we were not certain that these were the same.

Dr. H. M. Smith, who was collecting with me, obtained a specimen from a tree only a short distance away, likewise, near the same noisy rivulet.

At first I was inclined to believe, despite certain differences, that the specimens were the males of the form described as *Hyla erythromma*, a species collected at this locality at the same time of year, and likewise having red eyes. The single type was a female and lacked any trace of the remarkable gland. Female specimens of the present species were obtained in 1941, showing them to be unlike the known female of *H. erythromma*.

The spring and rivulet at Agua del Obispo is the type locality for four small hylids, *Centrolenella viridissima*, *Hyla erythromma*, *Hyla pinorum* and the present *Ptychohyla adipiventris*. The characters distinguishing these four small species are as follows:

- I. Body not bright green in life; ventral skin not transparent.
 - A. Eye not red, the tympanum concealed; a sharp, distinct tarsal fold extending entire length of tarsus; no yellow color on lip; tibiotarsal articulation to beyond end of snout; legs regularly banded, with narrow, brown, transverse stripes. *Hyla pinorum* Taylor
 - AA. Eye red; tympanum not concealed, none or only a faint trace of a tarsal fold.
 - B. Skin shiny smooth, not corrugated; snout rather pointed; heel to anterior edge of eye; a yellow diagonal stripe on top of upper arm; toes three-fifths or less webbed; nostril small; sole of foot nearly smooth, lacking distinct supernumerary tubercles; no ventrolateral gland. *Hyla erythromma* Taylor
 - BB. Skin distinctly corrugated; snout rather sharply truncate with swollen area about nostril and depression between; nostril large; terminal pads on digits larger than preceding form; on sole of foot very numerous distinct tubercles and granulations; heel to between eye and nostril; no stripe on arm. A ventrolateral gland. *Ptychohyla adipiventris* sp. nov.
- II. Dorsal part of body bright green in life, skin transparent on venter. *Centrolenella viridissima* Taylor

Hyla euthysanota Kellogg, a small frog from El Salvador, differing in having a dermal fringe on arm, foot and tarsus, and above vent, may be congeneric.

While no mention is made of the gland, there is a greatly reduced number of horny, nuptial spines (25) which suggests the

condition obtaining in male *Ptychohyla adipoventris* (25-55 in number). The specimens of *Hyla euthysanota* should be reëxamined to see if a trace of such a gland can be found.

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MAY 15, 1944

[No. 4

Two New Species of Crotalid Snakes from Mexico

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ABSTRACT: Two new rattlesnakes from México are described: *Crotalus semicornutus* from Mojárichie, Chihuahua, related to the *lepidus* group, and *Crotalus transversus* from the Ajusco Mountains, near Tres Cumbres, Morelos (elevation about 10,000 ft.). The latter species may belong in the *triseriatus* group as defined by Giloyd.

TWO species of the genus *Crotalus*, one from the high plateau region of southern México, the other from southwestern Chihuahua, are described as new.

Crotalus transversus sp. nov.

Type. Edward H. Taylor—Hobart M. Smith Coll. No. 30001; collected about 55 km. SW México (city), near Tres Marias (Tres Cumbres), Morelos, elevation about 10,000 ft., Aug., 1942, by E. Powell.

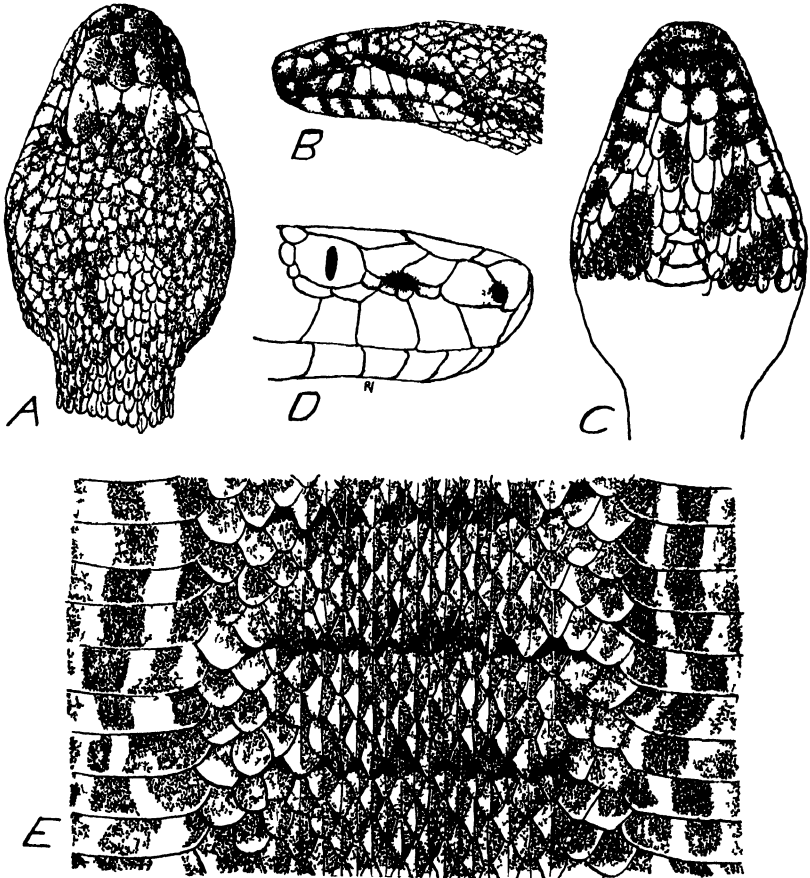
Paratype. EHT-HMS, No. 15879, purchased. México, exact locality uncertain (probably Ajusco range, Morelos).

Diagnosis. A small rattlesnake probably belonging to the *triseriatus* group, but not subspecifically related to any of the known forms. Characterized by 21-19-17 scale rows, upper labials, 8-10, lower labials 9-9. Ventrals, 147; subcaudals, 22-25. Labials separated from the eye by a single row of scales; one scale row only between canthals; upper preocular divided. Brownish with a median light stripe; 34-38 narrow, transverse black stripes on body; 5-7 on tail.*

Description of the type. Head flat, the supraoculars not elevated; rostral visible above, its posterior part rounding; internasals in con-

* There is some difficulty in counting the transverse stripes as many are broken. See figs.

tact, transversely elongate; canthals large, separated from each other by two superimposed intercanthals; a large pair of intersupraoculars, separating the supraoculars anteriorly, three or four small scales separating them posteriorly; occipital scales small, rather irregular. Nasal completely divided, the anterior and posterior parts of nearly equal areas; posterior nasal touching two labials, no loreals, three small scales border lower edge of pit; preoculars divided, the anterior part broadly in contact with posterior nasal, but separated from labial, lower preocular very small; two suboculars, the anterior (lacrymal) scarcely larger than the posterior, both in contact with the labials, three small postoculars. 9 (left), 10 (right), upper labials; 9 lower labials, the 3 anterior touch the enlarged chinshields, first labials in contact medially.



Scale rows, 33 (at 3d ventral), 21, 21, 19, 17; the two outer rows lacking keels; ventrals 147, the first separated from the chinshields by four pairs of small scales; anal single; subcaudals: 1 divided + 12 single + 9 divided = 22; six small rattles.

Color in alcohol. Brownish on sides, the median dorsal region lighter (salmon?); about 45 narrow black, more or less continuous, transverse stripes, on body and tail, which usually reach to the second scale row on the sides of the body; two outer scale rows with numerous small whitish flecks; ventrals with quadrangular dark marks forming irregular lines, the two outer series on each side darker and more distinct than the median. Head dark with an indistinct light stripe across the head at level of the anterior part of supraoculars; lower two-thirds of posterior upper labials whitish; first three labials dark; lower labials and chin spotted with black; the dorsal indefinite light stripe terminates anteriorly just back of occiput in a rounded, darker-edged spot; a black stripe from behind eye to angle of mouth, not bordered above by a light line.

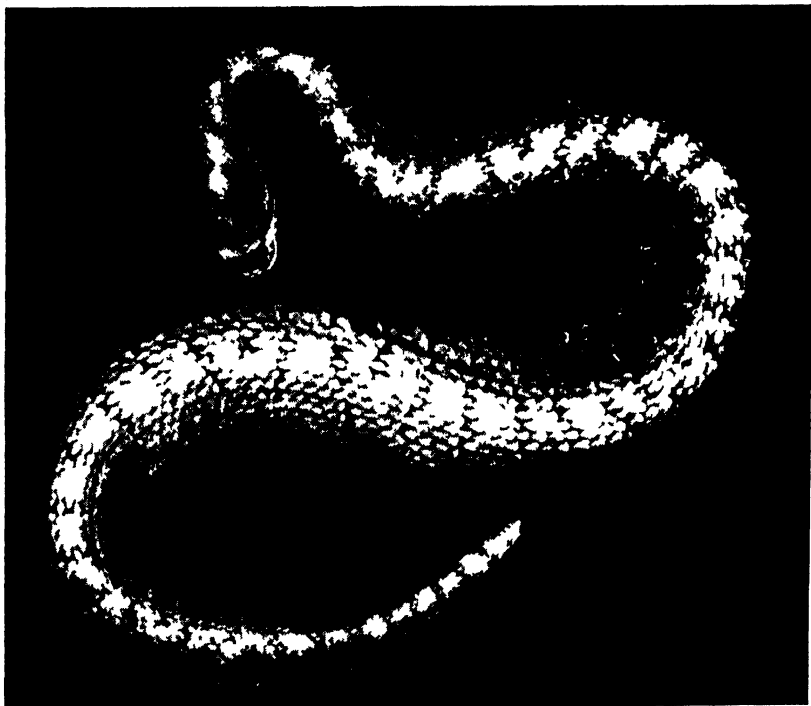
Measurements in mm. Total length, 464; tail, 38; width of head, 19; length of head, 19; length of rattles, 14.

Variation. The paratype is a small specimen from México, and very probably from the Ajusco Mountains between Tres Marias (Tres Cumbres), Morelos, and Cuernavaca. The body is grayish black, but the indefinite dorsal light stripe which terminates in a definite light spot on occiput is present; the body and tail are traversed by 39 narrow dark stripes a little more than two scales wide; a dark spot is present at each end of the stripe, which may touch the stripe, and there is also an indefinite series of small dark spots low on sides, between these latter; the pigment below is largely on the outer sides of the ventrals; the chin is spotted as in the type.

PLATE VI

FIG. A. *Crotalus transversus* sp. nov. Paratype, EHT-HMS No. 15879, México. (Somewhat reduced; actual length, 183 mm.).

FIG. B. *Crotalus transversus* sp. nov. Type, EHT-HMS No. 30001, 55 km. SW México (city) near Tres Cumbres, Morelos. (Somewhat reduced; actual length, 464 mm.).



There is a single elongate scale between the canthals. The internasals are less elongate; there are three anterior intersupraoculars. The labials are 8-8 above, 9-9 below. The scale formula and ventral count are identical with type; caudals: 22 (single) +3 (divided) =25. There is a single row of scales between labials and eye; no loreal, and only two instead of three small scales below the pit, and two instead of three postoculars. The total length of the specimen is 183 mm.

Remarks. That this form is not a subspecies of *Crotalus triseriatus* seems to be proved by the presence of *C. triseriatus anahuacus* in this immediate locality.

It may be distinguished from forms of *triseriatus* by the reduced number of scale rows, 21 as opposed to 23-25; a single row of scales between eyes and labials; reduced labial count and different squamation in loreal region, and the very distinctive marking and coloration.

Mr. Martín del Campo has recently described a small rattlesnake from the "Lagunas de Cempoala" (Zempoala) [Morelos or México] having a reduced squamation (scale formula 21, 19, 17, and 9 upper and lower labials). However, he describes the dorsal markings as "manchas dorsales, 45; caudales, 8." Since he does not describe the very characteristic color pattern of *transversus*, I conclude that he has correctly placed it as a variety of *Crotalus triseriatus anahuacus* Gloyd.

I am indebted to Dr. W. B. Davis, head of the Department of Fish and Game of the Texas Mechanical and Agricultural College, and Mr. Max Whisenhunt of the same institution, for the privilege of describing this striking new species, and for the gift of the type.

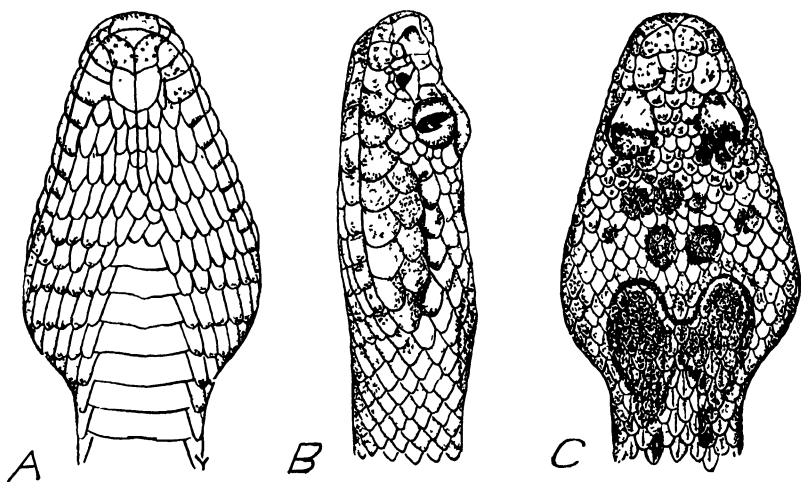
Crotalus semicornutus sp. nov.

Type. EHT-HMS, No. 23014 ♂; collected at Mojárichie, Chihuahua, 1939, by Irving W. Knobloch.

Diagnosis. A small rattlesnake with a single median series of dorsal blotches about five scales wide alternating with less distinct, paired spots; supraocular strongly elevated on its outer edge, much longer than its distance from tip of snout; upper preocular divided, the anterior part bending over edge of canthus, and separated from posterior nasal; a short, dark, light-bordered stripe beginning some distance behind eye and continuing to angle of mouth. One (lacrimal) or two scales between eye and labials; three or four loreals present; a pair of large internasals, in contact; a pair of large can-

thals separated by two pairs of scales; three series of scales between the supraoculars.

Description of the type. Head rather triangular, strongly distinct from neck; snout narrow, rather oval in profile; supraoculars large, strongly elevated on the edge, forming a hornlike ridge; a pair of very large internasals, in contact medially, separated from the supraoculars by large canthal scales, which are themselves separated medially by two pairs of small intercanthals; supraoculars separated



TEXT FIG. 2. *Crotalus semicinctus* sp. nov. Type. A. Ventral view of the head, $\times 2$. B. Lateral view of head, $\times 2$. C. Dorsal view of head, $\times 2$.

by three series of scales anteriorly and by four or five posteriorly; rostral broader than high, the part visible above triangular; nasal scales fused above nostril, sutured below nostril, the anterior part wider and longer than posterior; upper preocular divided, the anterior part largest, turning up over canthus; four loreal scales, the one between the postnasal and the anterior preocular, largest; others small; three scales border the pit, the lower scale separated from the labials by small intercalated scales (left side), or the anterior touching labial (right side); six postocular and subocular scales border posterior and inferior part of eye, the anterior subocular (lacrymal) largest, touching two labials; posterior suboculars separated from labials by one or two scales; 10 (left), or 11 (right) upper labials; mental triangular, its labial border greater than that of rostral; first pair of chinshields bordered by 3 (left) or 4 (right) lower labials; body scales keeled save outer row. Scale formula:

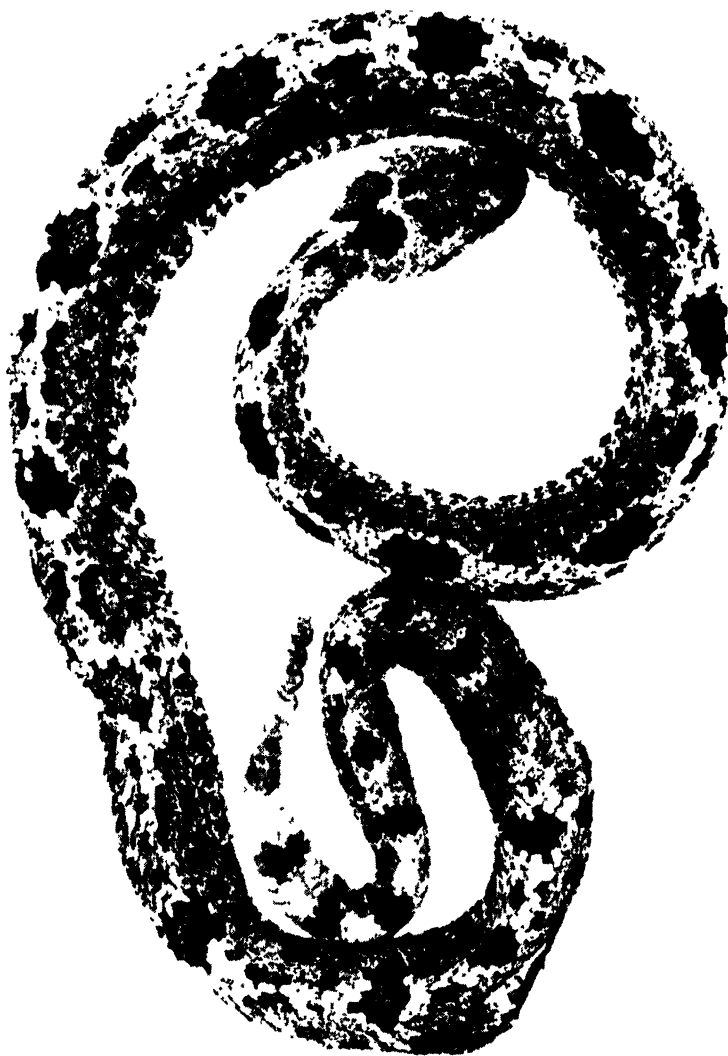


PLATE VII *Crotalus semicornutus* sp. nov. Type, EHT-HMS No. 23014, Mojtúachic, Chihuahua. (Somewhat enlarged; actual length, 493 mm.)

28, 25, 21, 23, 17, 17; ventrals, 167; 16 undivided subcaudals, followed by 3 divided scales; anal single; 13 scales about base of tail; 1 about middle of tail; six rattles present.

Measurement in mm. Total length, 493; tail 37.5; rattle 21.6; width of head, 17; length of head, 20.3; length of supraocular, 6.

Color. The dorsal ground color is pearl gray with the sides somewhat lavender-gray to pinkish salmon (low on side). On body a median series of about 16 very irregularly-edged dark spots, which alternate with smaller, irregular, more or less elongate paired spots (occasionally fused on posterior part of body or broken in two or three parts); an irregular row of dark flecks on the sixth scale row, each covering area equal to one scale; a similar series on the fourth row; still another row of dark flecks on first, second and third rows, the spots irregular and sometimes including parts of three scales, but usually covering a total area of about two whole scales; a pair of nuchal spots present, which are in contact medially; several small black spots on occiput, the anterior pair touching the supraoculars; an elongate dark stripe beginning behind eye is bordered above and behind by a whitish line; labials pinkish salmon, the upper labials heavily pigmented with ashy gray, the lower labials pigmented on their sutures; posterior half of tail somewhat orange above, yellowish below. Ventral surface dirty whitish with the anterior and posterior part of each ventral grayish or blackish, often covering more than half of the outer part of ventrals. Two black spots on the dorsal part of tail and one chestnut spot; ventral surface of posterior part of tail lacking dark markings.

Remarks. The relationship of the species is believed to be with *Crotalus lepidus*. It differs from that species in having a larger supraocular, much longer than its distance from the end of the snout, and in having the supraocular strongly elevated with a keel-like edge, allowing the upper fourth of the eye to be higher than the interorbital level. The color pattern is very different from that of typical specimens of *C. lepidus klauberi* (Gloyd) or *C. lepidus lepidus* (Kennicott) and the caudal scales are fewer. There is however a similarity in the general squamation; yellowish orange tail coloration and the presence of the pinkish-salmon coloration low on sides.

The specimen comes from an elevation of about 6,000 feet in the Sierra Madre mountains.

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MAY 15, 1944

[No. 5

A New Ambystomid Salamander from the Plateau Region of Mexico

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ABSTRACT: A salamander, *Ambystoma granulosum*, from the high plateau region of western México, México, is described. It is related to *Ambystoma bombypellum* Taylor.

A SPECIES of salamander, together with large numbers of salamander larvae, was obtained in shallow artificial ponds in the high prairie regions of western México (state). The dermal glands give the surface of the adult animal a somewhat granular appearance particularly if the glands are gorged, or the skin is slightly shrunken. There is no absolute proof that the larvae taken are the young of the species, but it is highly probably that they are.

Ambystoma granulosum sp. nov.

Type. EHT-HMS, No. 29805, collected at km. 74, about 12 miles northwest of Toluca, México, México, Sept. 10, 1939, by Edward H. Taylor and Hobart M. Smith.

Paratypes. Adults: EHT-HMS, No. 29804, collected with type; Nos. 24042-24044, at km. 70, northwest of Toluca, Sept., 1940, by Richard Clark Taylor and E. H. Taylor. Larvae: EHT-HMS, Nos. 24045-24250, kms. 70-74, 10-12 miles northwest of Toluca, México; U. S. N. M. Nos. 116630-116653, kms. 70-73, same locality. Taylor and Smith collectors.

Diagnosis. Related to *Ambystoma bombypellum*, but with a shorter, more elevated tail; body distinctly more elevated; limbs proportionally longer, the head shorter and broader. Color greenish or yellowish-olive to brown-olive above with numerous small black

spots. Yellowish or yellowish-brown on sides and venter, without marks. Tail spotted black like the back.

Description of the type. Head moderately high, its greatest width behind jaw angle (23 mm.) greater than measurement from tip of snout to gular fold (20 mm.), but less than distance from tip of snout to the gular groove, dorsally (30.2 mm.); length of eye (3.5 mm.), less than distance to nostril (4.8 mm.); distance between nostrils, 5.9 mm.; distance between orbits, 8 mm.; eyelid width, 1.8 mm.; length of snout, 7.2 mm.

A large, transversely oval, palatal pit; choanae transversely oval, the distance between them 7 mm.; prevomeropalatine teeth on a somewhat arched ridge, extending across palate, with a slight diastema between the prevomerine and palatine series; a slight indication of a mesial break in the dental ridge, but the teeth here are continuous. About 48-48 maxillary-premaxillary teeth, and approximately the same number of mandibular teeth, the latter forming a rather irregular series; about 11-13 prevomerine teeth; 9 palatine teeth.

Tongue rather small with longitudinal lamella (larger tongues in older specimens). The larval skinfold at corner of mouth still evident as a small flap on the upper lip and a small fold on back part of lower lip; no trace of splenial teeth.

Skin above finely corrugated or granular, more especially granular in caudal region; a groove behind eye curving down to near corner of mouth; gular fold prominent; the skin of chin forming longitudinal folds; a deep groove passing from corners of gular fold, half-way to the median dorsal line.

A double series of enlarged pits beginning medial to the nostrils and running back above orbit, then down behind it; another series of pits beginning behind nostril and covering much of the area below eye; another single series on the lower jaw. The dorsolateral, lateral and lateroventral neuromast organs represented by a few scattered pores. Twelve costal grooves, all of which can be traced across abdomen; limbs of moderate length; when adpressed the longest toes reach the wrist; an inner and an outer tubercle on palm and sole. Fingers 1, 4, 2, 3, in order of increasing length; toes 1, 5, 2, 3, 4; the distal part of metacarpals and metatarsals free; an indistinct ridge from outer toe onto tarsus; caudal fin thickened, scarcely distinguishable from remainder of tail; subcaudal fin much reduced and not or but little thickened; tail a little shorter than head and body; median part of tail deeper than base; cloacal walls with folds and with a small projection from the anterior part.

Color. Yellowish-olive above and on sides, darker on dorsum; venter dirty, or yellowish-flesh with a few scattered black spots on dorsum extending onto the sides; tail similarly marked.

Table of measurements (in mm.) of type and paratypes of
Ambystoma granuloseum.

Number	29805	29804	24042	24043	24044
Sex	♂	♀	♀	♂	♂
Snout to back end of vent.	92	81	89	92	86
Tail length	77	62	75	74	71
Head, greatest width.....	23	19	22	21	21
Head, length to gular fold (ventral),	20	20	20.2	20	19.5
Head, length to level of gular groove (dorsal)	30.2	27	28	28.8	26.3
Arm	32	26	29	29	27.5
Leg	34	28	30	32	28
Axilla to grom.....	45	38	41	45	40
Tail, depth at base.....	16	14	16	15	14
Tail, greatest depth.....	18	16	17	16.5	15
Depth of body.....	24.5	22	23.5	24	25

Description of the larvae. The largest larva, EHT-HMS, No. 24094, measures 90 millimeters snout to vent; the tail, 70. The head is broad (28 mm.); its length to base of gills, 36.5. The longest gills are 25 mm.

The dorsal fin arising at a point about on the level of the gill bases, and in the young, forms a continuous curve to end of tail, the dorsal part being most elevated near base of tail; elevation of subcaudal part of fin usually less than the dorsal, although a few specimens have it about equal to dorsal; when limbs are adpressed, tips of toes reach to elbow; web on the foot a little more extensive than in adult, involving the metatarsals to their tips.

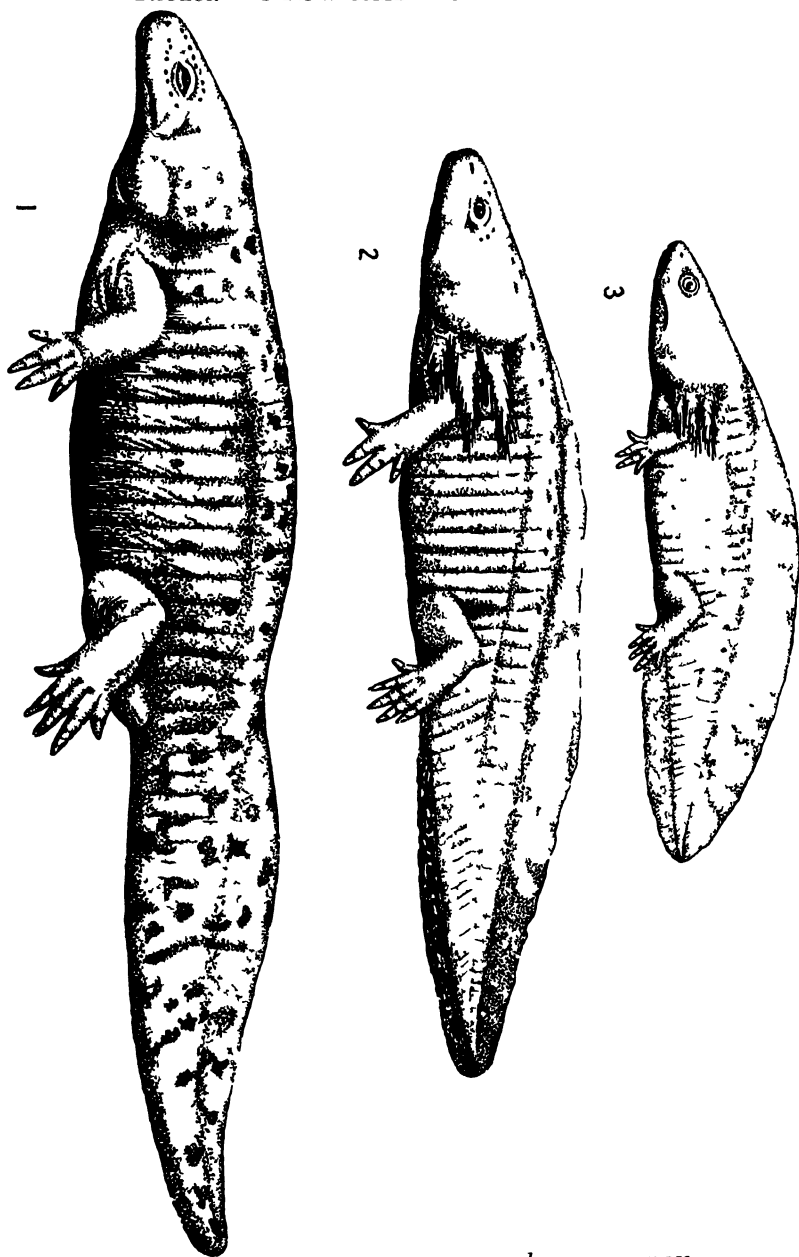
Maxillary-premaxillary teeth in a very uneven row, appearing as if there were more than a single row of teeth; prevomerine teeth on two strongly elevated, widened ridges, about 45 teeth on each, arranged in several series, many teeth directed backwards; the tooth groups, in contact mesially, lie anterior to a line connecting the choanae; the palato-pterygoid series in two longitudinal patches each with about 45 teeth, the teeth arranged in several transverse or diagonal series. About 60 splenial teeth on each side arranged in several short series. Mandibular teeth very irregular. Tongue undeveloped.

The larvae are light flesh color with little or no spotting on the back, or elsewhere. There is some pigment in the tail fin, especially near the tip and on the underside, some specimens having this region nearly black.

The figure (2) shows such a specimen, the ventral fin being less elevated than normal.

Remarks. The oldest adults (those in which the fold had been resorbed on the back part of the lower jaw, and the upper flap much narrowed) were dark dirty olive in color, the dorsal black spots discernible with difficulty. The prevomeropalatine series of teeth tend to straighten out more across the palate, and are less arched.

I have presumed that this species is related to *Ambystoma bombypellum* Taylor, a species known only from two recently transformed adults. These latter are uniform lavender in color, and the habitus is very different. In that form the skin is very smooth and shining. The body is not elevated medially; the tail is as elevated at its base as elsewhere, and the caudal fin is not retained in the adult (see fig. Univ. Kansas Sci. Bull., Vol. 25, 1938 (1939), plate XXIV, p. 303, fig. 1).

PLATE VIII *Ambystoma granulosum* sp. nov.

- FIG. 1 Type I HT-HMS No. 29805, 12 miles NW Toluca, Mexico, Mexico
About natural size
FIG. 2 Larva of same, nearly full grown ($\times 1$)
FIG. 3 Larva of same, young ($\times 1$)

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[No. 6

The Hylid Genus *Acrodytes*, with Comments on Mexican Forms

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ABSTRACT: The frog genus *Acrodytes*, Fitzinger (1843) (Hylidae), placed in the synonymy of *Hyla* by Boulenger (1882), is revived. Three Mexican forms are recognized. Of these two are new; one, from southern Guerrero, México, is described as *Acrodytes inflata*, because of a peculiar habit of inflating the body with air when calling. The other new species is being described elsewhere.

The name *Rana venulosa* (Laurenti) is based on a figure of a frog in Seba,* who states that its habitat is in "Indiis." It is doubtful whether it can be identified among the known forms of the genus.

THE Hylid frogs allied to "*Hyla venulosa*" (*auctorum*), having in the males a pair of vocal sacs extruded behind the angles of the jaws, are generically separable from the genus *Hyla* (*sensu lato*). These also have a characteristic pattern for the prevomerine tooth groups; broadened, somewhat spatulate, maxillary teeth with the transverse groove at their terminus giving the tooth in profile a seemingly more strongly bifid appearance than is usual in the *Hylidae*; a "paratoid" gland of considerable area, usually diffuse, on the head and back, giving the skin a thickened appearance, and producing secretions apparently physiologically different from those of other hylid species; palate more completely roofed with bone. Species having these characters, I believe, without question, form a natural generic group.

For this group there have been proposed two names: *Acrodytes* and *Scytotis*. *Acrodytes* Fitzinger, *Systema reptilium*, fasc. 1, 1843, p. 30, has as a genotype *Hyla venulosa* Daudin = *Rana venulosa*

* Seba, A., *Locupletissimi rerum naturalium thesauri accurata descriptio, et iconibus artificiosius expressio, per universam physices historiam*, Amsterdam, vol. 1, p. 120, pl. 76, fig. 1, 1734.

Laurenti 1768, *Synopsin reptilium*, 1768, p. 31 ("Indiis" *ex errore*)]. *Scytopsis* Cope, Proc. Acad. Nat. Sci. Philadelphia, Vol. 14, Sept., 1862, p. 354, has as genotype a Paraguayan species, *Scytopsis hebes* Cope (*loc. cit.* pp. 354-355) = *Hyla venulosa* (Laurenti) (*fide* Boulenger)]. Thus the same species apparently serves as genotype for both names, and the oldest, *Acrodytes*, must take precedence over *Scytopsis*.

It is of interest that Cope in 1862 used the Fitzinger name, *Acrodytes venulosa*, and later the same year described *Scytopsis* for his *Scytopsis hebes* which has been referred to the synonymy of *venulosa*. In 1865 (Nat. Hist. Rev., p. 109) Cope recognizes both genera, *Acrodytes* and *Scytopsis*, separating them on the basis of the presence of a paratoid in the latter, its absence in the former. Then in 1866 (Journ. Acad. Nat. Sci. Philadelphia, Vol. 6, Art. 2, 1866, p. 85) he refers the species *venulosa* to his *Scytopsis*.

There are three forms of the genus known to occur in México. They may be distinguished by the following characters.

- A. Adults lacking a dorsal pattern of black blotches (possibly present in very young), occasionally with pustules dark and some ventral stippling; eye larger, greater than its distance from nostril; known maximum size 70 mm, Chiapas. sp. nov.
- AA. Dorsal pattern of stripes or blotches, eye less than or equal to distance from nostril.
- B. The anterior dorsal marks separated from the posterior ones by a broad band of ground color, venter immaculate; maximum known size, male, 98 mm, (females much larger?), Guerrero (and ? Colima). *Acrodytes inflata* sp. nov.
- BB. Anterior marks usually two, dim, dark, dorsal stripes, with a light dorsolateral stripe; the anterior and posterior dorsal markings usually continuous; skin thicker on head and back; size, 83 mm, San Luis Potosí, Veracruz and Chiapas *Acrodytes spilomma* Cope

Acrodytes inflata sp. nov.

Type. EHT-HMS, No. 17890; collected near La Venta, Guerrero, June 27, 1938, by Edward H. Taylor.

Paratypes. EHT-HMS, Nos. 17889, 17891. Topotypes taken with the types.

Diagnosis. Very large tree frogs related to *Acrodytes spilomma*. Snout to vent, 98 mm. in males (females probably much larger); with large vocal sacs evaginated behind angle of jaws; prevomerine teeth in two broad, slightly curved, transverse series of 10-12 teeth, separated medially by a distance nearly equal to their distance from choanae; tympanum five-eighths of the diameter of eye; diameter of eye nearly equal to its distance from nostril; interorbital width distinctly greater than an eyelid; outer fingers one-third, toes three-fourths to four-fifths webbed; tibiotarsal articulation reaching the eye; no small yellow gland on distal part of posterior face of femur;

black dorsal markings; venter immaculate; paratoid glands present on occiput and back.

Description of the type. The head rather flat, with eyes much elevated; width of head (30 mm.) greater than length (25 mm.); eye large (8 mm.), equal to its distance from nostril; width of an eyelid (6.5 mm.) much less than interorbital distance (9 mm.).

Canthus rostralis lacking, the loreal region not or but slightly concave; snout slopes downward very abruptly from the region of nostrils, which are near the anterior point of snout; tympanum very distinct, a little higher than long, somewhat irregular in shape, its length (5 mm.) equal to five-eighths diameter of eye, and separated from the eye by a distance less than the length of tympanum.

Tongue much broader than long, slightly notched behind, only the posterior edge free; choanae transversely elongated, somewhat angulate on inner edge; prevomerine teeth in two transverse series, lying between the posterior edges of the choanae, and separated from the choanae by a distance equal to (or somewhat greater than) that between the two groups. Openings of the vocal sacs large, directed back; openings of the palatal glands form a sinuous groove, interrupted medially by small separate pores, and nearer to the front of the palate than to the prevomerine teeth.

Outer digits of hand about one third webbed, their edges with narrow skin folds; terminal pads only a little wider than digits; dorsal surface of pads with very pronounced, moundlike elevations; subarticular tubercles relatively small, that on outer toe larger, somewhat bifid; supernumerary tubercles rather indistinct, as are the palmar tubercles; base of first finger covered with an area of horn, granular, rather than spiny; none on second or third fingers.

Feet a little more than three-fourths webbed; toes with the terminal pads a little narrower than those on hand, but these likewise with narrow lateral folds; inner metatarsal tubercle flat, not strongly marked; a small indistinct outer tubercle; subarticular tubercles small; supernumerary tubercles indistinct; tarsal "fold" flat, widened, scarcely discernible.

Skin of head and body smooth; indistinct pustules present on back, more evident on sides; legs and arms nearly smooth; ventral surfaces of chin, breast, venter, and most of the under part of thigh strongly granular or areolate; no small gland present on distal part of the posterior surface of the thigh (present in *spilomma* and certain Central and South American species); a fold above the tympanum which encroaches somewhat on the latter.

Color. Dark reddish-brown above; some black spots on anterior part of the back, more or less connected; a broad transverse band of ground color separates the large indefinite black spot covering posterior part of back from the dark marking on the anterior; a few spots or flecks on the sides; arm and leg with black bars having somewhat lighter, irregular edges; rather large whitish-cream spots about anus; venter uniformly dirty cream; under sides of feet darker than palms.

Measurements in mm. of Nos. 17889, 17890, 17891; sex, ♂, ♂, ♂; snout to vent, 92, 95, 84; width of head, 30.5, 30, 29; length of head, 24.8, 25, 23; arm, 54, 58, 51; leg, 125, 127, 117; tibia, 41, 44, 38.5; foot, 55, 56, 50.

Variation. All three of the specimens have a reddish-brown ground color. The black mark on the back, originating on the eyelids, continues two-thirds of the length of the body, where it is interrupted. It may enclose areas of the ground color. The large spot in the lumbar region, reaching down on sides and extending back to near the anus, likewise may not be of solid color. The light areas near the anus and on femur may have some small blackish or brownish dots or reticulations. The pustules on the rump and back are more developed in the paratypes. The ventral coloration is the same in all. The type and one paratype both have the right choana abnormally narrowed.

Remarks. The three specimens were obtained from rainpools in scant forest during a light rain at night. They were calling when first observed and their bodies were inflated enormously, causing them to look like some monstrous *Hypopachus* save for the inflated, spherical, balloon-like vocal sacs behind the jaw angles. In such a disguise I did not suspect their true relationship when they were first encountered.

There is much confusion in the concept of "*Hyla venulosa*." Adequate series of specimens from South and Central America will doubtless prove the presence of several legitimate species in the large synonymy of that form as indicated in Boulenger, Neiden, and other authors. It would appear that the key character "vocal sacs behind jaws" has been responsible for the unwarranted synonymizing.

One Central American species of this group examined has the vomerine and palatine bones covered with curious dentate rugosities. This species may be *Hyla paenulata* of Brocchi, but this cannot be ascertained at this time.

I am of the opinion that "*Rana venulosa*" Laurenti, of unknown provenance, is unrecognizable, and the type figure might apply to several known species of the genus.

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PLATE No. IX. *Acrodytes inflata* sp. nov.

FIG. 1. Type, dorsal view about natural size, EHT-HMS No. 17890, La Venta, Guerrero, Mexico.

FIG. 2. Same. Head, lateral view. ($\times 1$)

FIG. 3. Same. Hand, ventral view. ($\times 1$)

FIG. 4. Same. Foot, ventral view. ($\times 1$)

PLATE IX



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[No. 7

A New Land Tortoise, *Testudo riggsi*, from the Middle Pliocene of Seward County, Kansas

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ABSTRACT: A new small land tortoise, *Testudo riggsi* sp. nov., is described from a middle Pliocene deposit in Seward county, Kansas. It constitutes a part of the local Saw Rock Canyon fauna.

INTRODUCTION

IN June, 1943, while engaged in coöperative geological work in Seward county, Kansas, with Doctor Thad McLaughlin, of the United States Geological Survey, we discovered fossil remains of two specimens of a small turtle. While turtle remains are probably as numerous as the remains of any other vertebrate in the Pliocene and Pleistocene of Kansas, they are as a rule broken and disarticulated so that only fragmentary parts of an individual are ever recovered. These fragments seldom warrant collecting since only rarely are they identifiable. However, the finding of these two specimens and their associated fragments gave promise to the securing of nearly complete individuals. The surrounding areas were carefully searched for all pieces of each individual. The associated parts of the carapace and plastron of each individual when found were disarticulated at the sutures and greatly fractured along the deep sulci which were present where the scutes meet, thus producing a thin structure in the heavily developed carapace. In the laboratory with tedious efforts the shells were pieced together. The restored carapace is slightly warped. Due to the broadly arched carapace the peripheral bones are nearly hidden from the dorsal view. I am greatly indebted* to Mr. Elmer S. Riggs, Honorary

* I wish to express my gratitude to Doctor E. H. Taylor for numerous helpful suggestions and criticism in the course of the study of these specimens.

Curator of Vertebrate Paleontology, who has generously given his time for the past year in helping with Museum and Field Work and especially for his painstaking labor in helping me in the reconstruction of the two specimens here reported. The species is named in his honor.

Testudo riggsi sp. nov.

Holotype. Kansas University Museum of Vertebrate Paleontology, No. 6789, a nearly complete carapace and plastron, of an adult turtle, showing 14 lines of growth. *Paratype*, No. 6790, complete plastron and nearly complete carapace, and parts of skeletal elements of an adult with 16 lines of growth.

Horizon and type locality. Middle Pliocene, Locality No. 6, Seward county, Kansas. Saw Rock Canyon fauna.

Diagnosis. Probably the smallest of the known fossil species of *Testudo* from North America; superficially resembling *Gopherus berlandieri* (Agassiz), being of about the same size, although possessing a much heavier carapace and plastron that are rugose in appearance due to lines of growth: gular portion of the epiplastron decidedly thicker; distinguished from known species of *Testudo* by its small size and the high broadly arched carapace.

Description of type. A land tortoise with a carapace length of 176 mm.; carapace width of 155 mm. or 82 percent of its length. The height of the carapace is 85 mm., or 48 percent of its greatest length. Greatest length of the plastron is 189 mm., and the greatest width is 140 mm. The scale and bone formulae of the carapace and plastron are as follows: Scutes: 1 nuchal, 5 vertebral, 1 pygal, 4 costals, 11 marginals, 1 gular, 1 humeral, 1 pectoral, 1 axillary, 1 abdominal, 1 inguinal, 1 femoral, 1 anal. Bones: 1 nuchal, 8 neurals, 1 suprapygal, 1 pygal, 8 costals, 11 peripherals, 1 epiplastron, 1 entoplastron, 1 hyoplastral, 1 hypoplastral, 1 xiphiplastron.

The carapace is decidedly convex with the lip or gular lobes projecting well in front of anterior margin of the carapace. The nuchal scute is well developed. The surface of the bone of the first costal scute on the right side has fourteen concentric lines of growth, which are deep and well formed. The fifth costal bone is rectangular in shape, being as wide at the distal end as at the proximal end. The seventh costal bone has a width of 22.8 mm. at the distal end as compared to a width of 12.6 mm. at the proximal end. There is only one suprapygal bone although it is broken where it joins the eighth neural bone and the suture is destroyed. The suprapygal

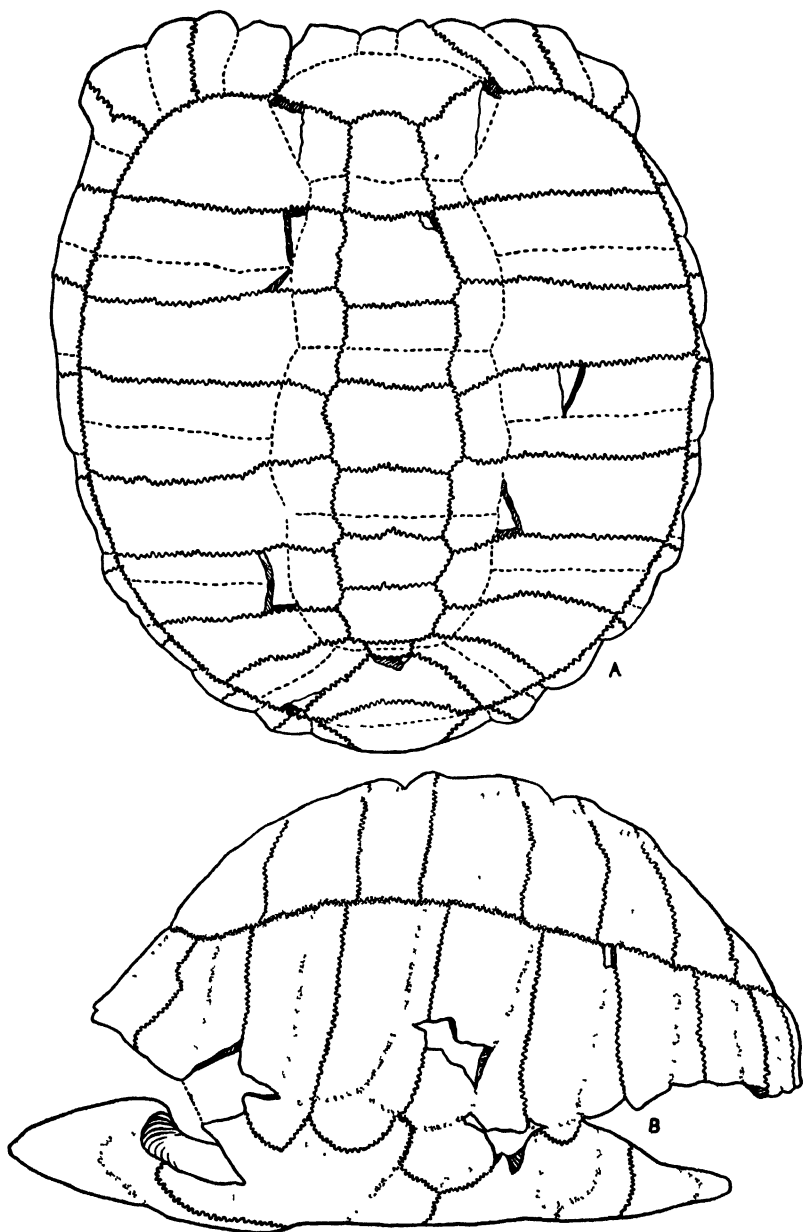


FIG. 1. *Testudo riggsi*, sp. nov. Type No. 6789, Kansas University Museum of Vertebrate Paleontology, Middle Pliocene Seward county, Kansas. A, dorsal view. B, lateral view. Drawings by Miss Barbara Barto.

is concave along its posterior border and joins the pygal bone which is convex anteriorly. The sulcus of the fifth vertebral scute crosses well down on the pygal bone. This region is similar to that figured by Hay¹ (1908, p. 429, fig. 561.) in *Testudo osborniana*, Hay, specimen No. 5871 A. M. N. H. The free margin of the pygal bone is 9.5 mm. wide forming a slight indentation in relationship to the adjoining free ends of the peripheral bones. The free borders of the peripherals are deeply notched and obtuse posteriorly, the greatest thickness being 16.5 mm. The greatest thickness of the anterior peripherals is 23.0 mm. The inguinal buttress extends but slightly above the costo-peripheral suture, though it is further expressed by a ridge on the inner surface of the sixth costal bone, extending approximately three-fourth of the distance along the midline of its inner surface. The ribs and vertebrae are missing.

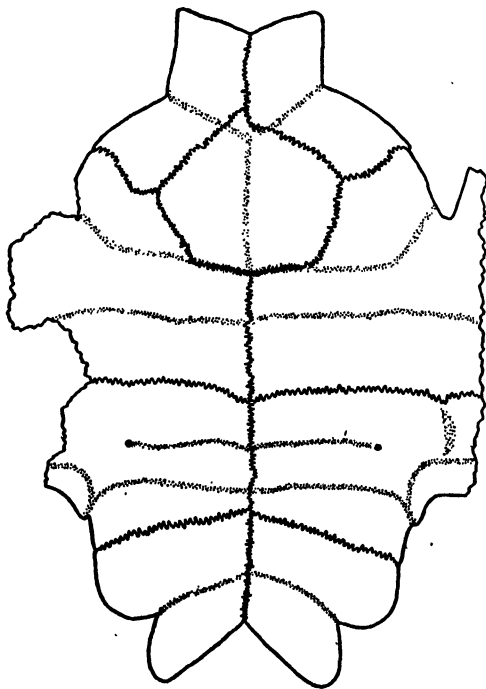


FIG. 2. *Testudo riggsi*. sp. nov. Ventral view of plastron of type No. 6789, Kansas University Museum of Vertebrate Paleontology. Drawing by Miss Barbara Barto.

1. Hay, O. P. 1908, The Fossil Turtles of North America, Carnegie Institution of Washington. Publ. No. 75, 568 pp, 112 pls., 794 figs.

Measurements of type and paratype

	Type mm.	Paratype mm.
Total length of carapace	176.0	185.0
Greatest width of carapace	155.0	165.0
Greatest height of carapace	85.0	
Length of bridge	81.5	85.0
Anteroposterior length of nuchal bones	37.1	42.5
Greatest width of nuchal bones	47.9	46.8
First neural bone (greatest length and width)	25.4-20.2	
Second neural bone (greatest length and width)	20.9-26.6	
Third neural bone (greatest length and width)	17.0-24.8	
Fourth neural bone (greatest length and width)	19.5-28.8	
Fifth neural bone (greatest length and width)	16.1-25.2	
Sixth neural bone (greatest length and width)	15.2-27.5	
Seventh neural bone (greatest length and width)	15.8-23.6	
Eighth neural bone (greatest length and width)	11.4?-10.2	
Suprapygial bone (greatest length and width)	34.0-42.6	
Pygal bone (greatest length and width)	28.2-44.0	
First costal bones (greatest length and width)	58.0-32.3	58.3-35.5
Second costal bones (greatest length and width)	62.0-24.0	
Third costal bones (greatest length and width)	68.0-19.3	
Fourth costal bones (greatest length and width)	67.8-23.6	
Fifth costal bones (greatest length and width)	70.5-19.3	
Sixth costal bones (greatest length and width)	59.0-19.6	
Seventh costal bones (greatest length and width)	56.4-21.8	
Eighth costal bones (greatest length and width)	36.3-16.0	
First marginal bone (greatest length and width)	27.5-23.8	
Second marginal bone (greatest length and width)	29.7-29.9	
Third marginal bone (greatest length and width)	32.3-24.2	
Fourth marginal bone (greatest length and width)	23.4	
Fifth marginal bone (greatest length and width)		
Sixth marginal bone (greatest length and width)		
Seventh marginal bone (greatest length and width)	44.9-23.8	
Eighth marginal bone (greatest length and width)	37.9-22.0	
Ninth marginal bone (greatest length and width)	27.0-23.5	
Tenth marginal bone (greatest length and width)	32.0-20.0	
Eleventh marginal bone (greatest length and width)	27.0-23.1	
First vertebral scute (greatest length and width)	41.8-51.0	
Second vertebral scute (greatest length and width)	35.5-46.5	
Third vertebral scute (greatest length and width)	36.8-51.9	
Fourth vertebral scute (greatest length and width)	37.0-46.5	
Fifth vertebral scute (greatest length and width)	36.9-54.5	
First costal scute (greatest length and width)	50.4-44.5	51.9-48.5
Second costal scute (greatest length and width)	56.5-37.3	
Third costal scute (greatest length and width)	56.3-37.0	
Fourth costal scute (greatest length and width)	45.5-42.5	
Greatest length of plastron	189.0	195.0
Length of plastron in midline	162.0	173.0
Width of plastron at axilla	105.0	105.0
Width of plastron at inguinal border	90.0	100.0
Length of free lateral margin of gular bone	22.0	25.0
Width of base of both gular lobes	41.5	43.5
Greatest thickness of gular lobes	27.4	29.7
Width of emargination of anterior gular lobes	36.0	17.0
Depth of emargination of anterior gular lobes	6.4	3.5
Greatest anteroposterior length of entoplastron	45.2	44.0
Greatest width of entoplastron	48.0	42.3
Greatest anteroposterior length of hyoplastral	65.4	68.1
Greatest width of hyoplastral	72.2	69.2
Greatest anteroposterior length of hypoplastral	51.3	57.5
Greatest width of hypoplastral	66.3	68.2
Width of xiphiplastron on anterior suture	44.6	49.3

	Type mm.	Paratype mm.
Length of xiphiplastron on median suture.....	30.5	29.6
Width of emargination of anal lobes.....	39.0	42.8
Depth of emargination of anal lobes.....	16.0	22.0
Greatest thickness of anal lobes.....	10.4	11.5

The paratype agrees with the type, except that it is slightly larger. There are other slight differences between the two specimens which may be individual variation, but which I have considered as sex differences. The type appears to be a male with the entoplastron thicker and flatter and a well-developed prominence posteriorly where the entoplastron joins the pectoral sulcus. The gular lobes or the lip are not as flared nor the emargination as deep as in the type. The paratype has a wider and deeper emargination in the xiphiplastron with the free edges thinner than in the type. The pits where the ischia rests on the xiphiplastron are relatively shallower. A few skeletal elements were recovered with the paratype although only the femurs are complete. These have an overall length of 54.9 mm.

Remarks. Although the skull is unknown the species has been assigned to the genus *Testudo* rather than to the genus *Gopherus* for the following reasons. (1) The bones of the carapace and plastron are deeply sculptured by lines of growth, a condition unknown in *Gopherus*. (2) The carapace and plastron are very thick in comparison with those of *Gopherus*. (3) The peripheral bones are obtuse and deeply grooved by the sulci of the scales and much thicker than those observed in *Gopherus*. (4) The costal bones are equally as wide or wider distally, than proximally, while in specimens of *Gopherus* examined (*G. agassizii* (Cooper) and *G. berlandieri*) the fifth and seventh costal bones are considerably narrowed distally and are tapering instead of rectangular in shape. (5) Only one suprapygial is present which is concave at the distal end instead of two which occur in *Gopherus*, the second being convex distally. The pygal in the fossil species is convex at the proximal end and extends well above the costo-peripheral sulcus while in *Gopherus* the pygal extends to the costo-peripheral sulcus.

Associated forms found in the deposit with *Testudo riggsi* were the specimens of *Pliomastodon adamsi* Hibbard, *Osteoborus progressus* Hibbard, numerous beaver teeth of the genus *Dipoides*,² and abundant mollusks. The associated invertebrates and vertebrates from this locality are designated as the Saw Rock Canyon (local) fauna.

² 2. The beaver teeth were sent to Doctor R. A. Stirton, Curator of Vertebrate Paleontology, University of California, for verification. In a letter of August 6, 1948, he writes, "The specimens from Seward county, Kansas, seem to be clearly referable to the *sigmodus-williamsi* group, of the genus *Dipoides*. This animal appears to be a well advanced Middle Pliocene

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MAY 15, 1944

[No. 8

A New Polycotyloid Plesiosaur

By E S RIGGS

ABSTRACT: A new specimen of plesiosaur from the Greenhorn Limestone formation of Kansas is described and figured as *Trinocromerum willistoni*: sp nov. The skull, vertebrae, shoulder and pectoral girdles are described and figured

AN important specimen of Cretaceous plesiosaur, recorded as No. 5070 in the University of Kansas Museum of Vertebrate Paleontology, has been turned over to this writer for study and description by the Curator, Dr. Claude W. Hibbard. Recognition of this courtesy and of the assistance of Miss Dorothea Franzen, staff artist, in preparing figures of the specimen is hereby acknowledged.

The specimen was found by a road crew in December, 1936, while making a cut on U. S. highway 81 south of Concordia, Kansas. The location is Sec. 16, T. 6 S., R. 3 W.; the horizon is 10 feet below the Jetmore Chalk member in beds which, farther west of this area, have been classified as the Hartland Shale member, Greenhorn Limestone formation, Cretaceous series.

The specimen consists of a skull with mandible, fifty vertebrae, many ribs, most of the pectoral girdle, both pubes lacking some sections, and the ischia almost entire. There are no paddle bones. The specimen is fairly well preserved, but is compressed and distorted in various parts. Owing to the greater elongation of the dental series, the absence of a well-defined inter-clayicular foramen and other lesser characters which will be pointed out in the detailed description, this specimen is designated as a new species. In recognition of the important work on the plesiosaurs of Kansas and elsewhere by the late Professor S. W. Williston, the name of *Trinacromerum willistoni* sp. nov. is proposed.

Trinocromerum willistoni sp. nov.

Type. University of Kansas Museum of Vertebrate Paleontology No. 5070. Skull with mandible, fifty vertebrae, many ribs and most of the pectoral girdle.

Type locality. Sec. 16, T. 6 S., R. 3 W., in a cut on U. S. highway 81 south of Concordia, Kansas.

Horizon. Ten feet below the Jetmore Chalk member in beds which, farther west of this area, have been classified as the Hartland Shale member, Greenhorn Limestone formation, Cretaceous series.

Diagnosis: Related to *Trinocromerum osborni*, but differing in having the premaxillaries extending farther back; in having a larger maxillary tooth series (at least 34 as compared to a possible 26), interclavicle relatively much larger, and lacking the large foramen.

Description of the type. The skull is long and tapering with narrow face and short cranium, similar to that of the well-known holotype of *Trinacromerum osborni* Williston (K. U. M. V. P. No. 1300). The specimen under study has the appearance of a fully mature individual, while the holotype of *T. osborni* shows a number of juvenile characters. The skulls of both specimens are laterally compressed. That of *T. osborni*, being preserved in the chalk, has a better surface texture and the sutures are quite readily recognized, while the former has suffered many minute fractures. These fractures, together with the more complete ossification, due to advanced age of the individual, make it difficult to trace some of the sutures. (See Fig. 1.)

The *premaxillaries* are long and narrow, extending backward to a point beyond the center of the orbit. The median articulation is well marked through the greater part of its length, but in a space of 100 millimeters anterior to the orbit it is lost in the relatively smooth and well-rounded surface. The articulation with the maxillaries and the nasal bones is less distinct, but traceable forward to a point

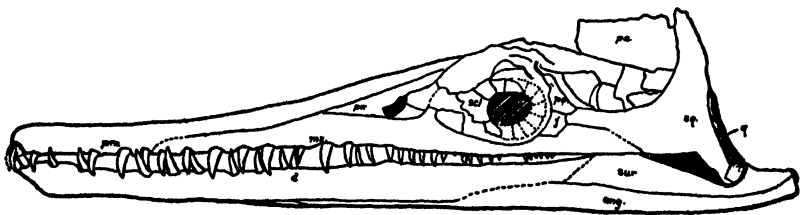


FIG. 1. Skull of *Trinacromerum willistoni* sp. nov., No. 5070, left side view. pm, premaxillary; mx, maxillary; pr, prefrontal; pa, parietal; po, postorbital; sq, squamosal; q, quadrate; d, dentary; ang, angular; sur, surangular.

above the seventh tooth, where it is lost. The posterior extremity of this bone is laterally compressed and terminates in a wedgelike form, enclosed between two laminae of the frontal bones. It differs from that of *T. osborni*, as described by Williston, in extending farther backward and in the evident characters of a more mature individual.

The *maxillaries* extend beyond the middle of the temporal arch. They are characterized by the very elongated dental series, including no less than thirty-four teeth as compared with a possible twenty-six in *T. osborni*. The teeth are uniformly large to a point about the middle of the series, then steadily decrease in size and in the interval separating them. The series terminates at a point below the posterior margin of the orbit, leaving an edentulous border of 70 millimeters. The greatest breadth of the maxillary is near the middle of the dental series; below the orbit it narrows to a diameter of 13 mm.

The *frontals* are not distinctly marked in their outlines. They apparently enclose and overlap the posterior extremity of the premaxillaries. There are, above the orbits, a pair of relatively prominent and rugose superciliary crests whose homologies are doubtful. In this specimen these crests are compressed, so that the superior wall of the orbit appears on the lateral surface. Neither the anterior nor the posterior articulations of the frontals has been determined.

The *parietal bones*, though laterally compressed in this specimen, were doubtless quite narrow. They present a thin vertical crest, extending backward from a point above the orbit. Whether or not they meet the premaxillaries remains in doubt.

The area, anterior to the orbit which should include the *lacrimal*s and the prefrontals is too badly fractured to admit of accurate description. The anterior part of the prefrontal is seen at the angle between the maxillary and the premaxillary.

The *squamosal*, as figured in many plesiosaurs, is a broad, branching bone with its posterior margin articulating with the quadrate and sending a superior branch upward so as to overlap the parietal and apparently meet its fellow in a crest. The anterior branch, more broad and flattened than the other, forms the greater portion of the temporal arch. There is no evidence of a quadratojugal element in this specimen and in deference to Williston's later conclusion that this bone does not occur in plesiosaurs,¹ no indication of its presence has been made on the accompanying drawing. How-

1. (*Trinacromerum*. Jour. of Geol. Vol. 16, 1908, p. 715.) (*Osteology of the Reptiles*, Harvard Univ. Press, 1925, p. 66.)

ever, it is observed that S. P. Welles² in a recent monograph on "Elasmosaurid Plesiosaurs," definitely described and figured it as present in *Hydrotherosaurus* and *Thalassomedon*.

The *quadrate* is a strong bone joining the squamosal posteriorly at a right angle and presenting its broad surface on the posterior aspect of the skull.

The *angular* extends forward beyond the middle of the dentary where it overlaps a small portion of the splenial as exposed in the lateral view.

The *mandible* is long, straight on its inferior border and tapering in breadth from the coronoid eminence to its anterior extremity. It articulates with the quadrate in an elongated glenoid fossa; the posterior member is strongly recurved and truncate at the extremity. The dentary bone is plainly marked, extending posteriorly to a point some 40 mm. from the end of the opposing maxillary. The dentition can be traced no farther than to a point below the center of the orbit, probably because of the imperfect preservation of the specimen. The surangular, is somewhat broader than the angular. The articular apparently does not project beyond the glenoid fossa so as to be seen on the lateral surface.

Measurements	mm.
<i>Skull</i> , alveolar border to occipital condyle.....	640
<i>Skull</i> , alveolar border to quadrate.....	692
<i>Skull</i> , length of maxillary.....	594
<i>Skull</i> , length of upper dental series.....	513
<i>Skull</i> , greatest breadth of maxillary.....	32
<i>Skull</i> , least breadth of maxillary.....	13
<i>Mandible</i> , greatest length.....	745
<i>Mandible</i> projection, posterior to articular surface.....	55
<i>Mandible</i> , depth at coronoid eminence.....	65

Some fifty vertebrae are included in this specimen, many of them entire though more or less laterally compressed. Of this number, fifteen are cervicals, including the atlanto-axis complex and the four succeeding cervicals in series.

The *atlas* and *axis* are combined to form one piece and, due to the mature age of this individual, are more or less coössified. Some of the sutures described by Williston in the holotype of *T. osborni* do not appear in this specimen. (See Fig. 2.)

The atlas consists of five parts: Two paired neurapophyses, two subtriangular odontoids and a single massive intercentrum. The neurapophysis of the right side is preserved, the left being separated from it at the median line and lost. This is a relatively broad, flat

bone which presents a small concave, anterior surface to the occipital condyle of the skull and joins by suture with the odontoid which has not been recovered in this specimen. Posteriorly, it joins the atlantar neurapophysis in a vertical suture. Superiorly it terminates in a short and laterally flattened, spinelike process; at the inferior extremity it joins the intercentrum. The axial intercentrum is a strong bone, having a hemispherically concave facet at its antero-superior surface. It occupies a median position and supports the occipital condyle from below. The inferior surface bears a slight median keel which extends along the posterior half of its length. It articulates posteriorly by suture with the axial intercentrum.

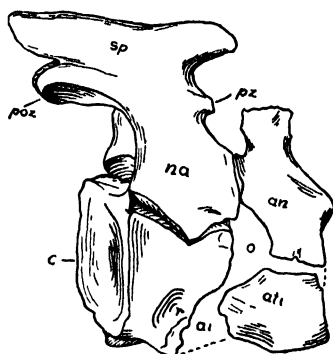


FIG. 2. Atlanto-axial complex. na, axial neurapophysis; c, centrum; ai, axial intercentrum; r, axial rib; pz, prezygapophysis; poz, postzygapophysis; an, atlantar neurapophysis; ati, axial intercentrum; sp, neural spine.

The *axis*, in its lateral aspect, approaches the general outlines of a typical cervical vertebra of this animal. It may be distinguished by the elongated neural spine, by the vestigial prezygapophysis and by the much reduced axial rib. The axial intercentra are paired bones, each of which joins an odontoid anteriorly and which extends posteroinferiorly, forming a part of the rib attachment and meeting the axial centrum in a curved suture. The axial rib, which is firmly coösisfied on the left side, is mostly broken away from the right. It is rounded, tapering and fanglike in form. The centrum is the larger and more massive part of this vertebra. Posteriorly, it presents a typical vertebral articulating surface to the succeeding cervical; superiorly it forms two-thirds of the footing of the neural pedicle.

The succeeding cervical vertebrae have moderately amphicoelous centra throughout and gradually increase in size as they approach the dorsal series. The sutures joining the pedicles and the cervical

ribs to the centra are plainly marked. The centra are apparently higher than wide. Their lengths are approximately equal to their height throughout.

Length of cervical centra, 26 mm. to 42 mm.

Greatest length of dorsal centra, 53 mm.

Pectoral girdle. The scapula is preserved on the left side only. (Fig. 3.) It is of the typical triradiate form, common to plesiosaurs. Though distorted by compression, it was evidently quite concave on the mesial surface and marked by a strong, rounded crest which forms the long axis of the bone. It is about one-fifth longer and correspondingly broader than the same in the type specimen of *T. osborni*. The proximal articular end, as seen in the lateral view,

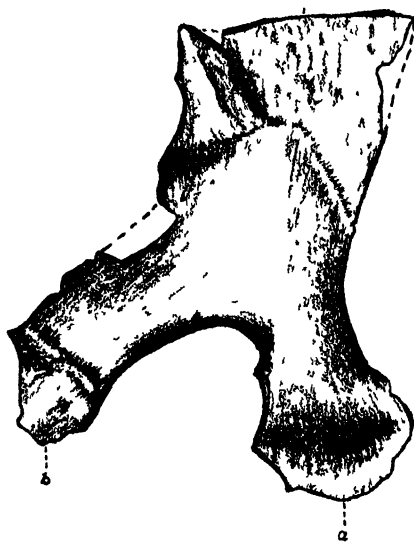


FIG 3. Scapula, lateral view. a, brachial articulation;
b, mesial branch; c, axial border

is uniformly rounded, in decided contrast with the two distinct facets observed in the smaller species. The mesial border is less strongly concave; the distal end is broad and presents a slightly curved extremity for cartilaginous attachment. The lateral ramus terminates in a surface moderately thickened and angular in outline, as seen from the lateral view.

The *clavicles* (Figs. 4, 5,) are both preserved, the right one almost in entirety, the left in normal relation with its fellow, but crumpled and broken in the lateral half. All of these parts are flattened from

compression in the matrix so that the natural concave form of the superior surface has been, to a large extent, lost. The two bones are separated anteriorly by a wide interval, filled in by the interclavicals. Posterior to this, the two elements join at the median

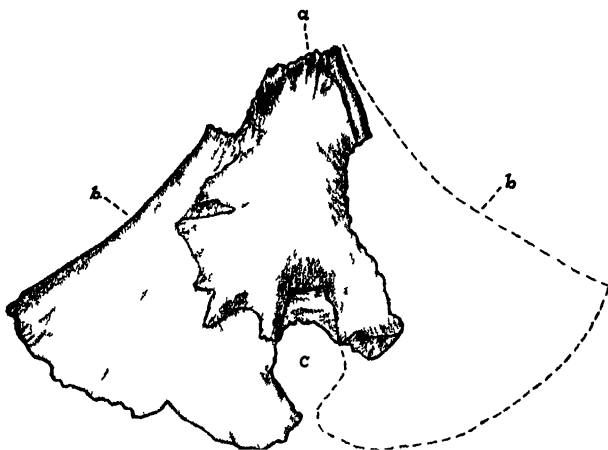


FIG 4 Clavicles and interclavicle, ventral view a, interclavicle, bb clavicles, c interclavicular vacuity

line in a serrated suture some 40 millimeters in length. Beyond this, and in the median line, is an irregular vacuity bounded by plates so thin and irregular in outline as to preclude the probability that this was a functional opening, homologous to the large inter-

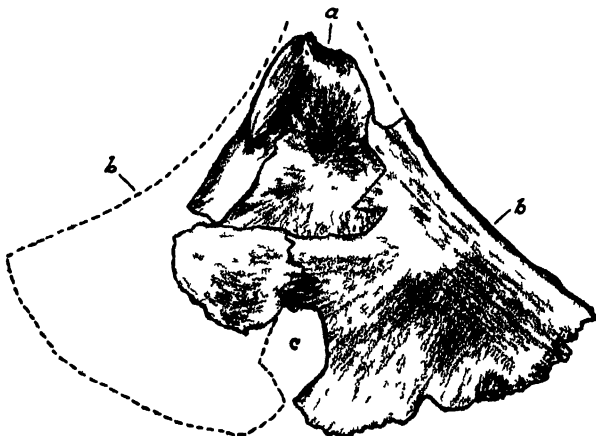


FIG 5 Clavicles and interclavicle, visceral view a, interclavicle, bb, clavicles, c, interclavicular vacuity

clavicular foramen described by Williston in *T. osborni* and erroneously described by Cragin (1888) as the pineal foramen of the cranium.

Each of the *clavicles* sends forward a narrow platelike branch which slightly overlaps the lateral surface of the interclavicle and may have joined anteriorly in the median line. Small parts missing from this section make it impossible to say what structure the anterior extremity of clavicles and interclavicles may have had.

The *interclavicle* is a thick and strong plate, concave on the

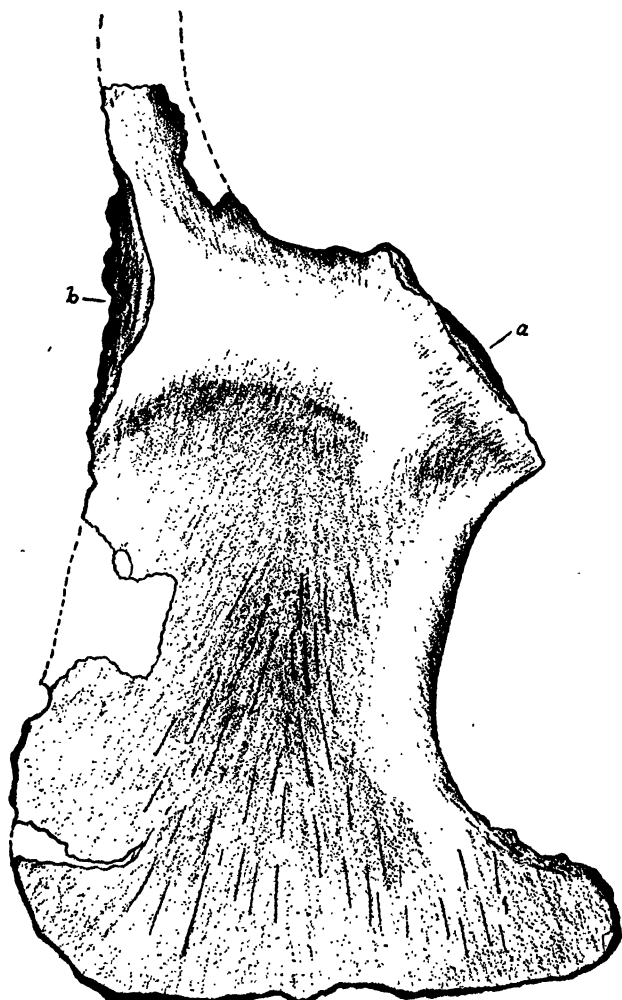


FIG. 6. Right coracoid, visceral view. a, brachial articulation; b, mesial border.

superior surface and rather strongly convex on the inferior. It lacks the prominent ridges which mark the inferior surface of this bone in the smaller species. The lateral margins are deeply serrated where they overlie the clavicles. A median indentation appears at the posterior border similar to that figured in *T. anonymum* Williston. It corresponds with the large interclavicular foramen in *T. osborni* and in *T. bentonianum*⁸ Cragin. The much greater relative size of this element, together with the absence of the large foramen, clearly distinguish this specimen from *T. osborni* and *T. bentoni-*

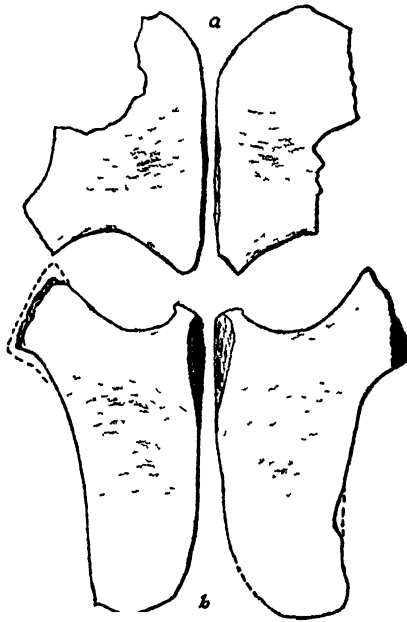


FIG. 7. Pelvic girdle. a, pubes; b, ischia.

anum. The small parts of *T. anonymum*, so far described, leave doubt as to its homologies.

The *coracoids* (Fig. 6) are well preserved in this specimen, the right one almost entire, the left broken into large sections with missing parts. As in *T. osborni*, the coracoids are broad, flat bones which present a lateral shoulder to the glenoid fossa, and are outlined by curved lateral borders and truncated posterior ends, each with a broad, lateral projection, and a straight margin at their median juncture. The glenoid articulation, forming the joint for

8. (N. A. Plesiosaurs, Williston 1908.)

the fore limb, is reinforced by a strong transverse thickening which produces a convexity on the superior surface. A narrow bar, partly broken in this specimen, extends forward from the anteromesial angle to meet the posterior margin of the clavicle. The small foramina appear near the mesial border of each.

Measurements	mm.
<i>Scapula</i> , axial length	254
<i>Scapula</i> , greatest breadth of glenoid ramus....	90
<i>Scapula</i> , estimated breadth of upper ramus.....	135
<i>Scapula</i> , greatest breadth across glenoid and superior rami....	222
<i>Interclavicle</i> , length at median line.....	118
<i>Interclavicle</i> , greatest breadth (estimated).....	146
<i>Clavicle</i> , breadth of left, from interclavicular suture.....	165
<i>Coracoid</i> , axial length of incomplete bone.....	470
<i>Coracoid</i> , greatest breadth at glenoid articulation.....	235
<i>Coracoid</i> , greatest breadth at posterior end.....	430

Pelvic girdle. The pelvis, as in most plesiosaurs, is less characteristic than the pectoral girdle. The pubes are more or less broken. They are broad, platelike bones, rounded in the anterior half of the median borders, slightly thickened and convex on the superior surface opposite the femoral articulation. (See Fig. 7, 8.)

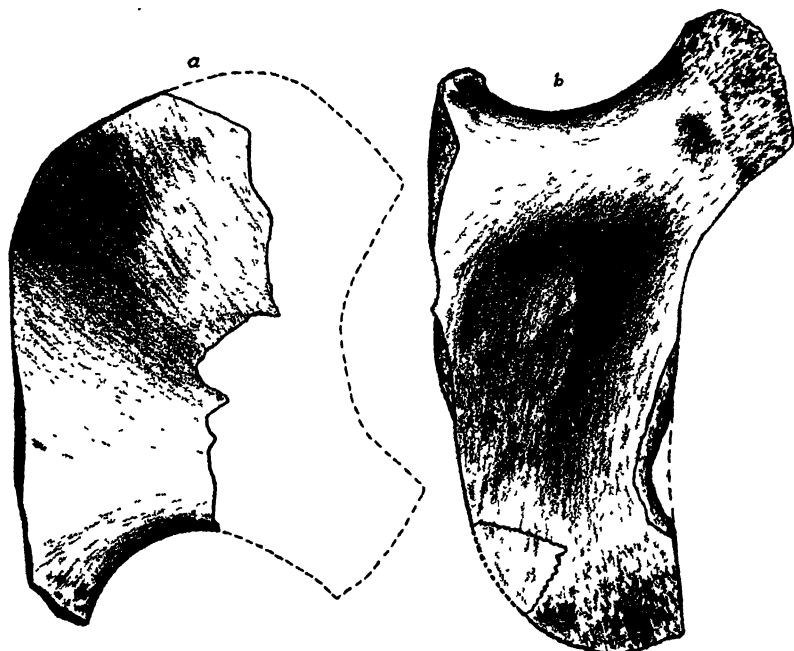


FIG. 8. Pelvic bones. a, right pubis, visceral view; b, right ischium, visceral view.

The *ischia* are almost entire. The anterior ends are convex on the superior surfaces and appreciably thickened to form a transverse bar to support the rear paddles. The greater, bladelike area is concave on the superior surface with the lateral margin considerably elevated.

Measurements	mm.
<i>Pubis</i> , greatest length near median line.....	275
<i>Pubis</i> , breadth of incomplete bone at femoral articulation.....	195
<i>Ischium</i> , greatest length over all.....	360
<i>Ischium</i> , breadth across anterior end....	205

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[No. 9

Remains of Birds from the Rexroad Fauna of the Upper Pliocene of Kansas

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ABSTRACT: From fossil bird remains from the Rexroad Fauna of the Upper Pliocene of Kansas, the following species are described as new: a duck, of the genus *Nettion*, a quail, genus *Colinus*, and a rail, genus *Rallus*. Aside from the described species, twelve other forms are recognized, four of which are referred to living species. The remaining forms are based on material too fragmentary to permit of specific identification.

THE Upper Pliocene deposits of Meade county, Kansas, through exploration by C. W. Hibbard, Curator of Vertebrate Paleontology at the University of Kansas and his assistants from 1936 to 1940, have given quantities of bones of the smaller vertebrates, the remains of mammals being especially abundant. With these there have been obtained many fragments of the skeletons of birds that Doctor Hibbard from time to time has forwarded to me for study. This report embodies the results of this work to date.

In brief résumé, these fossil deposits were first located in 1935 by men from a Civilian Conservation Corps camp who noticed various bones during quarry work in connection with a state lake project. They uncovered several large skeletons that were swept away and destroyed by a cloudburst. Doctor Hibbard came to the region in the summer of 1936, noted the smaller bones remaining, and began the careful sifting of the dump and the remaining deposits. The work continued during the summers from 1937 to 1940, with an extensive collection as the result. The present paper is the first report on the bird material obtained.

According to the account of Doctor Hibbard the region investigated lies along the valley of a stream tributary to Crooked creek

where the bird material was obtained at points designated as Locality 2 and Locality 3. Upper Pliocene deposits are found here in isolated areas, being exposed where streams have cut through the overlying strata of the Pleistocene. The bones are found in sand, sandy silt, clay, and bog material, with the sand in places consolidated. The bird bones in the main have come from the sandy areas, are light in color, and are easily broken. Occasional specimens are blackish brown, indicating deposition in boggy areas. Doctor Hibbard has designated the aggregation of species found in these Pliocene beds as the Rexroad fauna, and after analysis of the 32 identified species of mammals has indicated that this fauna has the approximate age in the upper Pliocene of the Blanco, Benson and Hagerman deposits, with closer affinity to the Blanco and Benson faunas.¹

Bones of birds from the Pliocene of North America for years were rarely found, and as yet the life of this age is poorly represented in our lists in comparison with that of the Miocene and the Pleistocene. The present collection is one of the most important that has been obtained as it gives the largest number of forms from a single locality. As the specimens were secured by sifting that saved the smallest pieces many are too fragmentary for successful identification. However, a fair number have been named, giving much useful information. Three species are described as new, a quail, a teal and a rail. There are fragments of several other species that are unknown to science, but that are represented by such fragmentary material that definite description is not warranted. I see no point in naming bones, that while obviously from unknown species, cannot be placed generically with the material available. Such indiscriminate naming is confusing, and is always a hindrance in subsequent studies when other specimens in the same groups become available.

The bones in this collection from the species of the Order Passeriformes present a problem as yet unsolved. This order in the avian class has a far greater aggregation of living species than any other, and there can be no question but that the multitude of forms was even more extensive in the later part of the Tertiary. Osteological differences among these are present but are often obscure. In the Rexroad material it is possible to segregate bones belonging to the

1. For further details and fuller bibliography see the following papers:
Hibbard, Claude W., Paleocology and correlation of the Rexroad Fauna from the Upper Pliocene of southwestern Kansas, as indicated by the mammals. Univ. Kansas Sci. Bull., vol. 27, No. 6, November 1, 1941, pp. 79-104, 1 text fig.

Frye, John C., and Hibbard, Claude W., Pliocene and Pleistocene stratigraphy and paleontology of the Meade Basin, southwestern Kansas. State Geol. Surv. Kansas, Bull. 88, December 5, 1941, pp. 889-424, 4 plates.

Fringillidae that are not like those of available skeletons of existing kinds, but of the several hundred species of this family recorded from the New World only a small part of those found now to the south of the United States are at present available. More than 175 species with several times that number of geographic races are known from North America and Central America, with a much larger group in South America. These are distributed among more than 100 distinct genera. While only a relatively small part of these reach Kansas today there is no question but that the variety there was greater at the end of the Tertiary than at present. There is also the certainty that numerous groups have become extinct before our time. Under these circumstances it has been necessary to leave the detailed study of the Passeriform specimens for later consideration when a larger variety of modern skeletons is at hand.

Of the identified specimens more than one-half belong to aquatic species that live in and around marshes, streams and ponds. Remains of turkeys represent birds of wooded areas, while parrots, pigeons and quail are species of forests, or regions where thickets and groves grow amid plains, prairies or savannas. The passeriform birds may have lived in prairie land, in thickets or in forests.

Of great interest are four birds that have been identified with species living today, the Rexroad occurrence being their most ancient records, carrying them back through the Pleistocene into the Upper Pliocene. While we may accept these Rexroad bones as specifically identical with the living representatives we may speculate on differences in the feathers that may have marked them as sub-specifically quite different.

Drawings illustrating the new species here described have been made for me by Sydney Prentice.

ANNOTATED LIST

ORDER COLYMBIFORMES. Grebes

FAMILY COLYMBIDAE. Grebes

Colymbus sp.

The material from Locality 3 obtained in 1937 includes the proximal third of a right tarso-metatarsus, No. 4484, from a grebe of the genus *Colymbus*. The bird is definitely smaller than *Colymbus auritus* and *C. nigricollis*, being similar in the size of the head of the metatarsus to *Colymbus chilensis* (Lesson), found today from southern Perú, Bolivia and Uruguay south through Argentina and Chile to the Straits of Magellan. The shaft, however, is decidedly

more slender. The bone represents an unknown species, but must for the present remain undescribed because of the incomplete material.

In 1938 the party secured at Locality 2 the distal half of a right coracoid, No. 4652, that possibly represents the same unknown species. This bone is smaller than the coracoid of *Colymbus nigricollis*, *C. auritus* or *C. occipitalis*, the last species being from southern South America, but is slightly larger than *C. chilensis*.

ORDER CICONIIFORMES. Herons, Storks and Allies

FAMILY THRESKIORNITHIDAE. Ibises and Spoonbills

Threskiornithid, sp. incert.

A left coracoid, No. 4741. with the sternal end missing, from Locality 3 is from an ibis smaller than *Plegadis* and *Guara*. The bone is highly interesting as it represents an unknown species probably allied to *Plegadis*, but from the fragment available the genus cannot be definitely determined. The species was one from one-fourth to one-eighth smaller than the modern white and scarlet ibises and the glossy ibises. The small size for a bird of this group is intriguing.

ORDER ANSERIFORMES. Screamers, Swans, Geese and Ducks.

FAMILY ANATIDAE. Swans, Geese and Ducks.

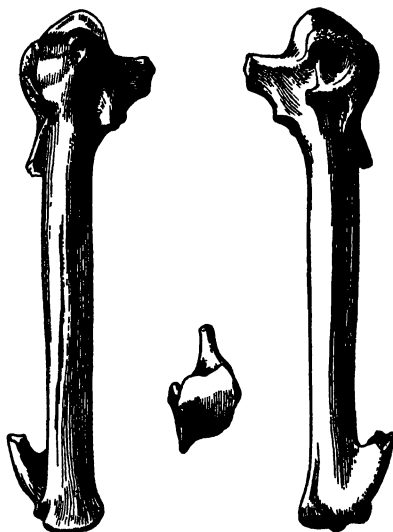
Nettion bunker sp. nov.

Characters. Carpo-metacarpus (figs. 1 to 3) similar to that of modern *Nettion carolinense* (Gmelin),¹ but metacarpal III and the proximal carpal trochlea distinctly heavier; metacarpal IV also heavier, as indicated by the proximal and distal unions with m III; facet for pollex larger.

Description. Type, right carpo-metacarpus with shaft of metacarpal IV missing, Kansas University Museum of Vertebrate Paleontology No. 3982, from Locality 3, Rexroad fauna, Ogalalla group, late Blancan age, Upper Pliocene, Meade county, Kansas, collected by Claude W. Hibbard and party in 1937. Carpal trochlea heavy, the internal one produced below in a sharp-edged compressed ridge; inner one with its lower margin notched so that its outline, as seen from behind, is definitely angular; a well-marked anterior carpal fossa, in form shallowly and irregularly cup-shaped; pisiform process moderate, but rising from a strong support that forms a straight-

1. *Anas carolinensis* Gmelin, Syst. Nat., Vol. 1, pt. 2, 1789, p. 533.

edged shelf at the base of metacarpal II, with another straight edge at right angles below, forming the distal margin of the internal ligamental fossa; metacarpal II compressed from side to side, with the point truncated and notched in front; facet for pollex expanded, with an irregular, rounded external projection; shaft of metacarpal III relatively strong, straight, rounded above and on its outer side, the inner and lower surface flattened, joining the outer face in an acute angle to form a long, straight ridge; tendinal groove faintly



FIGS. 1-3. Right carpo-metacarpus,
type of *Nettion bunkeri*, twice natural

impressed; metacarpal symphysis, or fornix, relatively strong; metacarpal IV missing except at proximal and distal union with metacarpal III; distal end truncated. Bone lightly fossilized, light brownish white in color.

Measurements. Total length, 35 mm.; transverse width across carpal trochlea, 4.3 mm.; transverse width of proximal end of Metacarpal III, 3.6 mm.

Remarks. The specimen, except for heavier size, is a close counterpart of the living green-winged teal *Nettion carolinense*. The total length of the carpo-metacarpus is that of the male of the modern bird, and the length of the union of metacarpals III and IV is also the same. The heavier shaft and the heavier carpal trochlea are distinctive, as is the stronger pisiform process, and the broader,

stronger articulation for the pollex. Comparative measurements of a male of *Nettion carolinense* (U. S. N. M. No. 224,084) are as follows: Total length, 35 mm.; transverse width across carpal trochlea, 3.9 mm.; transverse width of proximal end of metacarpal III, 3.1 mm.

In its larger size then the fossil has something of the same relation to the living green-winged teal that *Querquedula floridana* Shufeldt, described from the Pleistocene of Florida, has to the modern blue-winged and cinnamon teal.

Study of this specimen has led to reëxamination of the proximal end of a right metacarpal, U. S. N. M. No. 10,936, collected by J. W. Gidley from the Benson local fauna of the Upper Pliocene, 2 miles south of Benson in the San Pedro Valley, Arizona. This bone in 1924² I listed under the heading of *Querquedula*, species. In the twenty years since I first examined this specimen the National Museum collection of skeletons of modern skeletons of the Anatidae of the New World has been increased until adequate series of a number of species are at hand. These indicate that one of the differences in the carpo-metacarpus in *Querquedula* and *Nettion* is found in the metacarpal symphysis, which measures in length approximately 7 mm. or more in *Querquedula discors*, and 6.0 mm. or less in *Nettion carolinense*. The proximal end is quite similar in the two. The Benson fossil has the transverse measurement across the carpal trochlea 4.3 mm., and the transverse breadth of metacarpal III at its proximal end 3.7 mm. These measurements are definitely heavier than living *Querquedula discors* or *Q. cyanoptera*, and agree exactly with the fossil *Nettion bunker*i from the Rexroad formation. The form of the pisiform process and the angles at its base are also identical. The specimen therefor is referred to *Nettion bunker*i.

The species is named for Charles D. Bunker, of the Kansas State University Museum of Natural History, in recognition of his fruitful labor in building the collections long under his care, and of the writer's close association with him for many years.

Charitonetta albeola (Linnaeus) Bufflehead

A nearly complete tarso-metatarsus, No. 3984, was found at Locality 3. This specimen exhibits characters found in a series of eight skeletons of the modern bird, and from its size may have come from a female individual. The middle trochlea has the groove for the articulation of the basal phalanx very slightly broader, with the

external flange at the distal end slightly lower, than in several of the modern specimens, but the condition is almost equaled in two others. The difference is very slight and is probably individual. In general conformation the fossil checks closely otherwise with the modern material.

The bufflehead has been reported previously from the Pleistocene of Fossil Lake, Oregon, and from the asphalt beds at McKittrick, California. The Rexroad specimen is the first record for the Pliocene.

The study of this Rexroad material has led to examination of certain other fossil specimens that I have identified in the past, among them three fragmentary metacarpals, U. S. N. M. No. 16749, from the Pleistocene of Florida, obtained by W. W. Holmes in Pinellas county, Florida. In 1931³ I listed these under *Querquedula floridana*, an extinct teal known from the Pleistocene beds of Florida. Since that time the National Museum has built up larger series of the skeletons of the Anatidae so that the characters of the skeleton may be better understood. On further study now it develops that two of the Pinellas county metacarpals in which metacarpal No. 3 and the distal fornix are practically complete are those of *Charitonetta albeola*. The third with the distal end missing may be referred to the same species. The record constitutes another locality for this species in the Pleistocene.

Anatidae, not identified

Bones of ducks are common in the Rexroad collection but except for the type of *Nettion bunkeri* and the specimen of the Bufflehead are too fragmentary for specific identification. Possibly five species are represented, perhaps one or two more, as indicated by size differences and other variations.

Three fragmentary humeri are slightly larger than living blue-winged or green-winged teal, as is one broken coracoid. Possibly these may have some connection with *Nettion bunkeri*, but this is uncertain.

Slightly larger ducks are represented by the worn distal end of a tibio-tarsus, and parts of a scapula, a coracoid, and an ulna.

There is a coracoid and a scapula of one still larger form, and the broken coracoid and part of a femur of another, the one last mentioned being a little smaller than a mallard.

3. Smiths. Misc. Coll., vol. 85, No. 2, April 13, 1931, p. 22.

ORDER FALCONIFORMES. Vultures, Hawks and Falcons

FAMILY ACCIPITRIDAE. Hawks

Buteo sp.

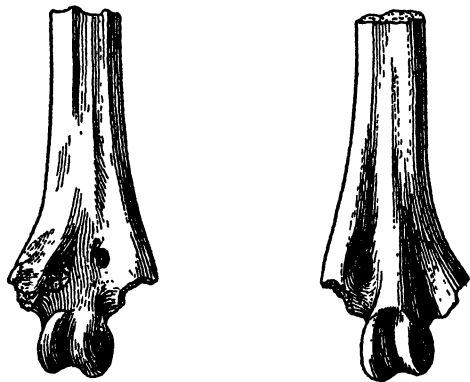
In miscellaneous bones secured in the season of 1937 there is the anterior end of a sternum, considerably worn, that comes from a large hawk about the size of the red-tailed hawk *Buteo jamaicensis*.

ORDER GALLIFORMES. Megapodes, Curassows, Pheasants and Hoatzins

FAMILY PHASIANIDAE. Partridges, Quails and Pheasants

Colinus hibbardi sp. nov.

Characters. Distal end of tarso-metatarsus (figs. 4 and 5) similar to that of modern *Colinus virginianus* (Linnaeus) ⁴ but decidedly larger; shaft stronger, and more heavily lined by the tendinal grooves.



FIGS. 4-5. Distal end of right tarso-metatarsus (fragmentary), type of *Colinus hibbardi*, three times natural size.

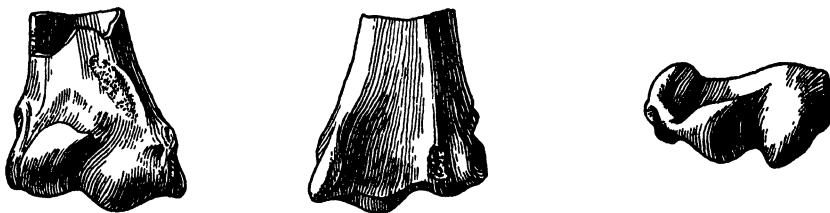
Description. Type, Kansas University Museum of Vertebrate Paleontology No. 3981, distal portion of right tarso-metatarsus, with the main parts of the outer trochlea missing, collected in 1937 from Locality 3, Rexroad Fauna, Ogalalla group, late Blancan age, Upper Pliocene, Meade county, Kansas, by Claude W. Hibbard and party. Shaft strong, flattened distally, with three sharply angular lines marking tendinal grooves on posterior surface; facet for hallux large and well marked; anterior face with a broad, shallow groove leading

4. *Tetrao virginianus* Linnaeus, Syst. Nat., ed. 10, vol. 1, 1758, p. 161.

down into the relatively large inferior foramen; outer trochlea missing except for the expanded base; middle trochlea strong, elliptical in lateral outline, with its lateral faces slightly excavated; a shallow groove extending clear around the articular surface, beginning in a definite depression on the anterior face; the outer flange bordering this groove slightly heavier than the inner, and on the posterior face extending farther up toward the inferior foramen; inner trochlea, with distal tip missing, strongly developed. Bone white, with a slight brownish tinge, well preserved though not heavily silicified.

Measurements. Transverse breadth of shaft below center, 3.1 mm.; transverse breadth across trochlea (approximate), 7 mm.; transverse breadth of middle trochlea, 2.9 mm.

REMARKS. In spite of its fragmentary condition it is readily evident that this specimen comes from a *Colinus*, and on comparison it



FIGS. 6-8. Distal end of right humerus, Kansas University Museum of Vertebrate Paleontology No. 3997, identified as *Colinus hibbaridi*, three times natural size.

is so definitely large that there is no difficulty in separating it as a distinct species from the modern forms. Its characters are such as to place it with *Colinus* and to separate it from *Lophortyx* and *Callipepla*. *Lophortyx* differs in the more angular development of the posterior side of the middle trochlea. *Callipepla* has more slender form throughout. *Cyrtonyx* is decidedly different, as in spite of the stocky form of the shaft the trochleae are reduced in size.

The distal end of a right humerus, No. 3997, was secured at Locality 3, likewise in 1937. This specimen (figs. 6 to 8) is well preserved and little worn. In general it is like *Colinus virginianus* except for slightly larger size. The brachial depression is relatively larger, with the ridge bordering it longer, extending farther up the shaft. The bone has the size of an adult male of *Cyrtonyx montezumae mearnsi*, but the trochleae are definitely smaller. *Callipepla squamata* is fairly close to *Colinus virginianus* in the form of this

part of the humerus, but has the radial trochlea larger, this being actually about as large as in the fossil though the latter is from a bigger bird. *Lophorytyx californica* and *L. gambeli* have the brachial depression definitely smaller. In the fossil the transverse breadth across the trochleae measures 18 mm. In two *Colinus virginianus* this dimension is 16.7 and 17.1 mm. The difference in bulk is easily apparent on direct comparison.

The distal end of a left humerus, No. 4660, was collected in 1938 at Locality 2 in Meade county, a bone that is so badly worn that it can barely be identified. It also measures 18 mm. in transverse breadth across the trochleae, but offers no other points that are pertinent.

Study of these specimens has led to critical examination of *Colinus eatoni* Shufeldt⁵ described from an unknown geological horizon in western Kansas. The type material according to Doctor Shufeldt consists of a left carpo-metacarpus and the proximal phalanx of an index digit. The description is brief, but from the illustration it appears that the metacarpal may come from some oscinine Passeriform bird, possibly an Icterid, or a Fringillid, a matter to be decided by examining the original bone. The digit may represent another species of bird. The species, therefore, is to be removed from the genus *Colinus*.

Colinus hibbardii is named for Claude W. Hibbard in recognition of his painstaking and careful work in developing the Rexroad fauna.

FAMILY MELEAGRIDIDAE. Turkeys

Meleagris gallopavo Linnaeus. Turkey

A left tibio-tarsus, with the shaft shattered in the region of the peroneal ridge, was obtained in Locality 3. This bone was broken but the fragments were present so that it could be repaired and restored until the conformation is as it was originally. The specimen is one of moderate to small size, and agrees in all of its characters with modern specimens of the wild turkey.

It is the first record of this species from the Pliocene.

Meleagrididae, sp. ?

The proximal third of a scapula, No. 3993, taken at Locality 3, in 1937, comes from a turkey-like bird of rather small size. It differs from the turkey, *Meleagris gallopavo*, and from the ocellated turkey, *Agriocharis ocellata*, in lacking a pneumatic foramen on the outer

5. Trans. Connecticut Acad. Arts Sci., vol. 19, February, 1915, p. 70, pl. 18, fig. 108.

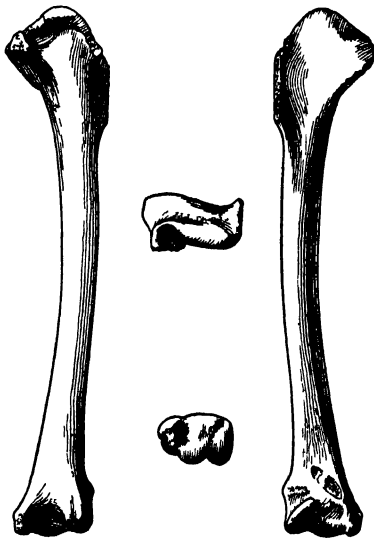
face between the furcular articulation and the glenoid facet. The form also is more slender. The generic identity of the bird represented by this fragment is uncertain. It may be noted that the specimen is very dark brown in color, quite different from the other bird bones in this collection, an indication that its method of preservation has been different.

ORDER GRUIFORMES. Cranes, Rails and Allies

FAMILY RALLIDAE. Rails, Gallinules and Coots

Rallus prenticei sp. nov.

Characters. Humerus (figs. 9-12) rather similar to that of modern *Rallus himicola* Vieillot⁶ but slightly heavier; crista superior



FIGS 9-12 Right humerus, type of *Rallus prenticei*, twice natural size.

longer and heavier; ectepicondylar prominence slighter; trochleae relatively smaller; entepicondylar prominence slighter.

Description. Type, right humerus, nearly complete, Kansas University Museum of Vertebrate Paleontology No. 3865, from Locality 2, Rexroad fauna, Ogallala group, late Blancan age, upper Pliocene, Meade county, Kansas, collected by C. W. Hibbard and party in 1936. Proximal end of bone averaging strong and heavy compared with related modern rails; head merging smoothly into shaft on

6. *Rallus himicola* Vieillot, Nouv. Dist. Hist. Nat., vol. 18, 1819, p. 558.

anconal aspect, with a strong external tubercle; capital groove in outline a rectangle, the bottom slightly excavated, slightly under cut at lower margin, otherwise with the walls rising at a right angle from the base; internal tubercle relatively strong (distal point missing); crista superior relatively long (free margin partly broken), with a prominent attachment for the pectoralis major; a considerable concavity on the anconal aspect below the internal tubercle, but no open pneumatic foramen; palmar aspect of head with a lightly marked deltoid groove; bicipital surface smooth, slightly convex; shaft fairly strong, with a slight flexure; line of attachment for latissimus dorsi slightly marked; lower end of shaft expanding slightly to support the distal trochlea; impression for brachialis anticus rather small, more heavily impressed toward outer margin; ectepicondylar process small, projecting slightly; radial and ulnar trochleae both rather small; entepicondylar process small; external and internal tricipital grooves very lightly marked; olecranal fossa shallow; distal end of entepicondyle (slightly worn) not projecting beyond distal level of ulnar trochlea; groove between ulnar and radial trochleae broadly open. Bone very light brownish white in color.

Measurements. Total length, 36.1 mm.; greatest breadth across head, 7.1 mm.; transverse breadth of shaft at center, 2.1 mm.; transverse breadth through trochlea, 5.1 mm.

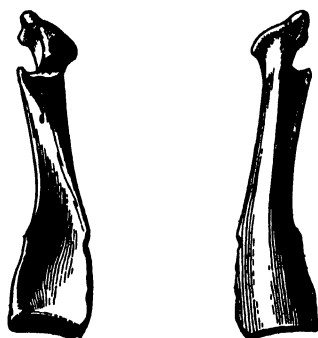
Remarks. While in length the type humerus is similar to the living Virginia rail *Rallus limicola* it is slightly though definitely heavier. The greater length and strength of the crest for the attachment of the large breast muscle is especially evident and would seem to indicate a bird of more active powers of flight. There is, however, a lesser development of the articulations of the lower end of the humerus.

A second humerus, No. 3866, from the left side, with the anterior third more or less missing, was collected at Locality 3 in 1937. This bone so far as it is preserved is in excellent condition and seems somewhat more silicified than the type. It comes from a slightly larger individual as indicated by the following measurements: Transverse breadth of shaft, 2.6 mm.; and transverse breadth across trochleae, 5.3 mm. The size differences are those found between male and female of the modern Virginia Rail, so that it is reasonable to suppose that the type may be from a female individual and that the broken bone from Locality 3 comes from a male.

Comparable measurements of the humerus of the Virginia Rail have been taken from male and female of that bird collected in

Meade county, Kansas, in December, 1942, by Henry Hildebrand for the Museum of Natural History of Kansas University (catalogue numbers 23216 and 23217). These have been loaned to me for study through the courtesy of Charles D. Bunker. The measurements follow, that of the humerus of the male being given first in each instance: Total length, 39.0, 36.1 mm.; greatest breadth across head, 7.0, 6.7 mm.; transverse breadth of shaft at center, 2.2, 2.0 mm.; transverse breadth through trochleae, 5.1, 4.6 mm.

In 1937 a right coracoid, No. 3867, was secured at Locality 2 that obviously refers to *Rallus prenticei* (figs. 13 and 14). The bone has



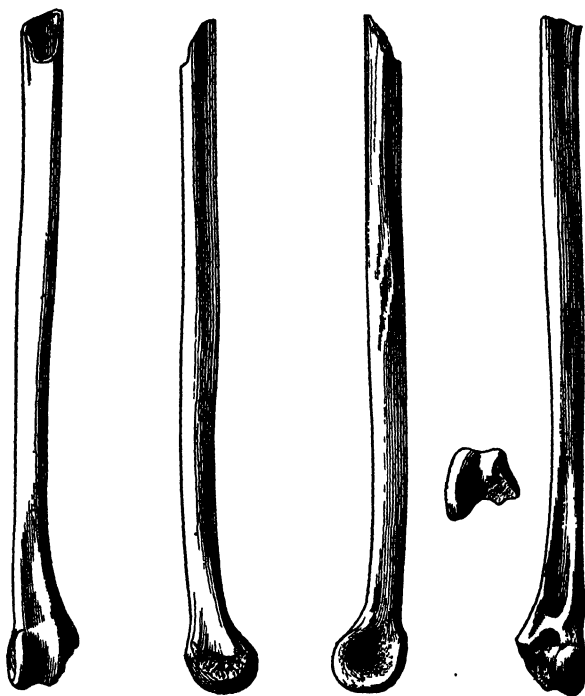
FIGS. 13-14. Right coracoid, Kansas University Museum of Vertebrate Paleontology No. 3867, identified as *Rallus prenticei*, twice natural size.

the outer angle, adjacent to the sternal articulation, and the end of procoracoid missing, but otherwise is complete. Except for definitely larger size it is closely similar to the Virginia Rail. In total length the fossil measures 21.6 mm., while in the largest male Virginia Rail available (U. S. N. M., No. 322701, a bird of unknown locality) this dimension is 18.5 mm. The sternal facet in the fossil is well developed, and the bone as a whole is definitely larger and stronger than in the modern species. A second coracoid from the left side, No. 3868, with the sternal end missing, was obtained in 1937 at Locality 3.

In 1936 the broken distal end of a right tarso-metatarsus, No. 3869, was found at Locality 2. The trochleae are all broken, so that the only note of importance that may be made is the observation that the shaft at its lower end is slightly larger than in the male of the modern Virginia rail.

In the same year of 1936 the distal end of a right tibio-tarsus, No. 3870, was collected at Locality 2, a bone with the condyles somewhat worn so that most of the finer characters are gone. This bone also is definitely heavier than the corresponding one in the male Virginia rail, measuring 2.7 mm. at the smallest transverse diameter of the shaft, this being 2.3 mm. in the largest modern bird. The distal end also is obviously heavier.

The final specimens consist of a right humerus with the head missing, No. 3871, and a left tibio-tarsus (figs. 15 to 19) with the proximal end gone and the distal end considerably broken, No. 3872,



FIGS. 15-19. Left tibio-tarsus, with the proximal end missing, Kansas University Museum of Vertebrate Paleontology No. 3872, identified as *Rallus prenticei*, twice natural size.

that were found in 1936 at Locality 2 lying on top of the dump left by enthusiastic if ill-advised excavations on the part of the young men of the Civilian Conservation Corps who had discovered this deposit of fossil bones. From their exposed situation Doctor Hibbard was not entirely certain that these bones might not be of Recent age. They appear slightly whiter than the majority of the

bones from this place, but there is variation in this regard, some of the undoubted upper Pliocene material being equally white. The humerus has the slightly stockier form with smaller trochleae and slighter ectepicondylar process of *Rallus prenticei*. The tibio-tarsus seems to be from an immature individual that may not have quite attained full growth. The shaft is more slender than the other seen, but the distal end is heavy in spite of the immaturity indicated by the partly developed form of the supra-tendinal bridge. It also is *prenticei*. I believe that there can be no doubt that these two bones belong in the upper Pliocene with the other Rexroad material.

This extinct rail, from consideration of all the bones described, apparently was a bird slightly larger and stockier in build than the living Virginia Rail *Rallus limicola*. Apparently it was common in this locality as its remains are among the most abundant of those preserved.

Fulica americana Gmelin. Coot

The distal end of a left humerus, No. 3994, was collected in 1937 at Locality 3, the bone being in excellent state of preservation. With it there was found a complete left ulna, No. 3988. This species has been recorded widely in the North American Pleistocene from Florida and Texas to Oregon and California, and is here reported for the first time from the Pliocene.

ORDER CHARADRIIFORMES. Shore-birds, Gulls and Auks

FAMILY SCOLOPACIDAE. Snipe, Woodcock and Sandpipers

Scolopacidae, sp. ?

A species of sandpiper of small size is represented by the distal half, more or less, of a right humerus, No. 4488, from Locality 3. The end of the ectepicondylar process is missing, and some of the other processes show wear. The bone is about the size of the humerus in *Pisobia fuscicollis*, and the species may have been one near that group of sandpipers. It does not seem practicable to identify it more definitely at present.

FAMILY LARIDAE. Gulls and Terns

Sterna sp.

In 1937 the party secured a fragmentary left carpo-metacarpus, No. 3989, at Locality 3 that is identified as a tern of the genus

NOTE.—This species is named for Sidney Prentice, now deceased, loyal alumnus of Kansas University, in recognition of his skill and accomplishment in the delineation of vertebrate fossils.

Sterna. The bone lacks much of the head and most of the third metacarpal. It is about the size of the corresponding bone in Forster's Tern *Sterna forsteri*.

ORDER COLUMBIFORMES. Sand-grouse, Pigeons and Doves

FAMILY COLUMBIDAE. Pigeons and Doves

Zenaidura macroura (Linnaeus). Mourning Dove

A left humerus, No. 3995, with the distal end missing, collected at Locality 3 in Meade county in 1937, is typical of the Mourning Dove. While the White-winged Dove *Zenaida asiatica* (listed in the fourth edition of the A. O. U. Check-list published in 1931 under the generic name *Melopelia*) is similar in size, the tuberculum laterale on the posterior dorsal surface of the head is definitely longer and heavier. In the smaller size of this tubercle and in all of its other details the fossil agrees completely with *Zenaidura macroura*.

The mourning dove has been found in Pleistocene deposits in Pinellas county, Florida, and at McKittrick and Rancho La Brea, California, but is here first recorded from the Pliocene. The size of the fossil is that of male examples of the modern bird.

ORDER PSITTACIFORMES. Parrotlike Birds

FAMILY PSITTACIDAE. Lories, Parrots and Macaws

Psittacidae, sp. ?

The proximal end of a left metacarpal from Rexroad Locality 2, collected in 1938, comes from a parrot of medium size. It represents a bird smaller than the Thick-billed Parrot *Rhynchopsitta pachyrhyncha* and larger than the White-fronted Parrot *Amazona albifrons*, but except for this there is not much that may be said about it. The pisiform process is gone, and the specimen is considerably worn otherwise. There is no question but that it represents an unknown species, but the material is too fragmentary to allow proper allocation except to family.

ORDER PASSERIFORMES. Perching Birds

Passeriformes, not identified

The siftings from Localities 2 and 3 of the Rexroad fauna have given us premaxillae, maxillae, humeri and occasional other bones of perching birds, some of them preserved in excellent condition. These have been segregated but after some study for the present are left unnamed. The Order is the most abundant of existing birds as

to species. The great majority are small in size, and many show surprising similarity in form of the bones of the skeleton. It is difficult to identify individual bones of many of the species of the Order that now live in the Plains area of the United States. When to this difficulty we add the further complication of the antiquity found in the Rexroad specimens the situation becomes so involved that at this time I do not care to attempt to identify the species that are represented. There is no question but that several are new to science but to merely name these without being able to assign them to a proper place in relation to the others that are known would only add to our fossil list without contributing in any way to our systematized knowledge. Description should wait for a time until our collections of the modern species, particularly among the vast number found in the region to the south of the United States, are more complete.

In the material at hand there are at least two species, probably more, of Fringillidae, and one Icterid. Others probably include other species of these families and of Compothlypidae. All appear to belong to the suborder Passeres, and all are of small to medium size.

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[No. 10

Two New Mammals from the Middle Pliocene of Seward County, Kansas

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ABSTRACT: *Osteoborus progressus* sp. nov. and *Pliomastodon adamsi* sp. nov. collected from middle Pliocene deposits along the Cimarron river in Seward county, Kansas, are described.

INTRODUCTION

IN June, 1943, while working with Doctor Thad McLaughlin of the United States Geological Survey, in Seward county, Kansas, we located a new middle Pliocene bone deposit along the Cimarron river. Fragments of vertebrates are common in these beds, but time did not permit any collecting, with the exception of picking up material exposed on the surface. In the small collection made at that time are the remains of two new Pliocene mammals. Invertebrates were also found associated with the vertebrates. There is a possibility that a new "High Plains" fauna can be secured at the locality in the future.

SYSTEMATIC DESCRIPTIONS

Osteoborus progressus sp. nov.

Plate X; figs. 1-4

Holotype. No. 6791, Kansas University Museum of Vertebrate Paleontology. Fragmentary lower jaws, the right half bearing P_3 — M_3 ; the left bearing P_4 — M_2 .

Horizon and type locality. Ogallala formation, middle Pliocene, Seward county, Locality No. 6, Kansas.

Diagnosis. A large dog nearly as large as *Osteoborus validus* (Matthew and Cook) with a large P_4 approaching the size and

shape of that tooth in *Boroghagus*. The tooth joins M_1 with a square cut contact. The posterior cusp is absent on P_4 and the cingula are greatly reduced. M_1 with reduced metaconid.

Description of holotype. Lower jaws badly crushed at symphysis. Incisors and canines missing with the exception of a broken canine found in the matrix beside the lower jaws. The left jaw is less distorted and contains P_4-M_2 with the alveoli of the other teeth missing. The jaw is deflected outward beneath P_4 and the teeth are set in a slightly curved series. P_4 , M_1 , and M_2 are well worn. P_3-M_3 are present in the right jaw. The posterior part of the canine alveolus is present, although there is no evidence of P_1 or P_2 , probably due to the crushed condition of the jaw. P_3 is set slightly transverse in the jaw. No accessory cusps are present on the tooth. It is unworn and crowded toward M_1 due to the fact that the crown of P_4 had been broken off in life and only the roots remain. M_1 has a reduced metaconid in comparison with the M_1 of *Osteoborus cynoides* (Martin). M_2 worn and rectangular in outline. M_3 much smaller than M_2 and shows but slight wear.

Measurements (in millimeters) of holotype of *Osteoborus progressus*, KUMVP No. 6791 and the holotype of *Osteoborus cynoides* (Martin) KUMVP No. 3468.

	<i>Osteoborus progressus</i>	<i>Osteoborus cynoides</i>
P_3 , anteroposterior diameter	9.5	7.8
P_3 , greatest transverse diameter	6.5	5.0
P_1 , anteroposterior diameter	17.5	14.85
P_4 , greatest transverse diameter	12.4	10.5
M_1 , anteroposterior diameter	27.8	25.5
M_1 , greatest transverse diameter	11.9	11.7
M_1 , transverse diameter across heel.....	10.7	9.5
M_2 , anteroposterior diameter	12.0	12.3
M_2 , transverse diameter	8.5	8.6
M_3 , anteroposterior diameter	6.9	....
M_3 , greatest transverse diameter	5.6	....
Depth of ramus between P_2 and P_3.....	....	24.4
Depth of ramus beneath P_4	39.5	21.3
Depth of ramus beneath M_1	39.1	23.8

Discussion. *Osteoborus progressus* has a much heavier jaw than *O. cynoides*. The development of P_4 separates it from the other known forms of *Osteoborus* in that it is heavily developed, possesses no accessory cusps and the posterior cingula are poorly developed; also P_4 has a square contact with M_1 , a character found in *Boroghagus*. The presence of the metaconid on M_1 retains the form within the genus *Osteoborus*.

Pliomastodon adamsi sp. nov.

Plate XI

Holotype. No. 6788, Kansas University Museum of Vertebrate Paleontology. Maxillaries containing right and left M^2 — M^3 .

Horizon and type locality. Ogallala formation, middle Pliocene, Seward county, Locality No. 6, Kansas.

Diagnosis. Largest of the North American *Pliomastodon* known from upper dentition. Upper tusks rounded with no evidence of enamel bands. The external cingulum between the first and the second crests of M^3 forms a well developed tubercle.

Description of holotype. The specimen was badly weathered and eroded. The upper molars are in place in the maxillaries and intact but the amount of warping is not known. The anterior crests of M^2 are separated by a distance of 95.0 mm. The fourth crests of M^3 are separated by a distance of 60.0 mm. M^2 is greatly worn and only the outline of the crests remain. M^3 consists of four well developed crests and a small fifth crest. The first two crests of M^3 are well worn and there is no evidence of a trefoil pattern. The inner cusp of the third crest possesses a poorly developed trefoil. The presence of tubercles between the crests of M^3 are few. The largest developed tubercle is formed from the external cingulum between the first and the second crests. A very small external tubercle is present between the second and the third crests. An internal tubercle is present between the third and the fourth crests and it is the size of that tubercle in *Mammot*.

Four feet of a shattered tusk was associated with the maxillaries. It was round in cross section and there was no evidence of enamel on the surface. The greatest diameter of the tusk was four and one-half inches.

Measurements (in millimeters) of *Pliomastodon*

	<i>P. adamsi</i> Holotype	<i>P. nevadensis</i> Holotype	<i>P. vexillarius</i> Holotype
M^2 , anteroposterior diameter	100.6	112.0	107.0
M^2 , transverse diameter across third crest..	77.5	71.7	71.0
M^3 , anteroposterior diameter	179.0	155.6	158.0
M^3 , transverse diameter across first crest...	86.0	.....	80.0
M^3 , transverse diameter across fourth crest,	73.0	.....	71.0

The measurements of *Pliomastodon nevadensis* are after Stock (1936) and those of *P. vexillarius* are after Matthew (1930). *Pliomastodon matthewi* Osborn and *P. cosoensis* Schultz are smaller forms based upon the size of the upper teeth. *Pliomastodon sellardsi* Simpson from the lower Pliocene of Florida is known from the lower jaws and dentition.

The species is named for Messers Horace Adams, A. W. Adams, and Raymond A. Adams who own the XI Ranch and who have co-operated in every way possible to make our work a success in that region.

Discussion. Since the skull and lower jaws of *Pliomastodon adamsi* are unknown, its relationship to the other forms is not known. The genus *Pliomastodon* had a wide geographical range in North America during the Pliocene but it appears to have been less abundant than the other mastodonts whose remains are rather abundant.

The specimen was taken from a gray sandy silt approximately 20 feet above the jaws of *Osteoborus progressus*.

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PLATE X

Osteoborus progressus sp. nov.

FIG. 1. Holotype, No. 6791, Kansas University Museum of Vertebrate Paleontology; lingual view of left ramus, P₄—M₂, anteroposterior diameter 58.9 mm.

FIG. 2. Holotype, No. 6791, occlusal view of left ramus, P₄—M₂.

FIG. 3. Holotype, No. 6791, lingual view of right ramus, P₃—M₃.

FIG. 4. Holotype, No. 6791, occlusal view of right ramus, P₃—M₃.

PLATE X

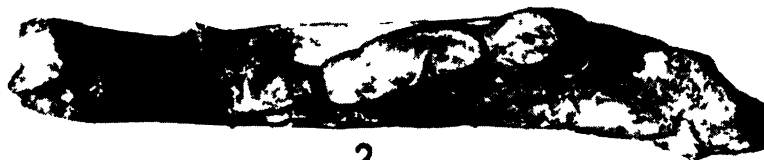


PLATE XI

Pliomastodon adamsi sp. nov.

Holotype, No 6788, Kansas University Museum of Vertebrate Paleontology; occlusal view, RM² and RM³. Reduced. Anteroposterior diameter 272 mm.

PLATE XI



THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

VOL. XXX, pt. I]

MAY 15, 1944

[No. 11

Present Location of Certain Herpetological and Other Type Specimens

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ABSTRACT: The present location of all the holotype specimens described by Edward H. Taylor is given, with their present museum numbers. A list is appended of all other type specimens in the Edward H. Taylor-Hobart M. Smith Collection (EHT-HMS).

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INTRODUCTION

BECAUSE of numerous inquiries as to the present whereabouts of certain type specimens described by me, and because of a specific suggestion from Mr. Graham Netting, Curator of Herpetology at Carnegie Museum that such a publication was desirable, I have prepared the following list. It purports to give the present location of all holotype specimens described by me alone or under joint authorship, and their present location and, when known, their present museum numbers. For convenience the type locality and publication has been included. Owing to the fact that the date of publication (mailing date) of many of the papers containing type descriptions, differs one to two years from the printed date on the publication, I have appended a complete bibliography with dates of publication authenticated as nearly as possible. While most of the descriptions deal with herpetological species, one monograph describes several new mammals. These forms, too, are appended to the list for the sake of completeness.

It is impossible to learn the fate of collections in the Philippine Islands (Nov., 1943). Queries made in 1941 as to changes in numbers, if any, were unanswered. Whether or not the types herein listed have survived the bombing of Manila awaits to be ascertained.

I am aware of the desirability of having included the present taxonomic status of each species, inasmuch as certain ones have been referred to synonymy or placed in different genera. In many cases the changed status is recorded, where I have synonymized the form or where the reference seemed to have been based on reasonable judgment and an opportunity to examine a proper material. In other cases where the reference has seemed unwarranted, that is, based on material other than typical, or due to a different understanding of taxonomic categories, or where I have been unable to verify the reason for the action, no change or comment has been made. Certain literature references containing proposed changes may have been overlooked.

AMPHIBIA

GYMNOPHIONA

ICHTHYOPHIS GLANDULOSUS Taylor.

Holotype.

Type. Cal. Acad. Sci., No. 60073. Originally EHT, No. 1595A.*Publ.* Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 516-517, pl. 3, figs. 4, 5.*Type loc.* Abung-Abung, Basilan I., P. I. *Coll.* E. H. Taylor, Oct. 23, 1921.

ICHTHYOPHIS WEBERI Taylor.

Holotype.

Type. Bureau of Science, No. B 1.*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 227-228.*Type loc.* Malagan River, Palawan, P. I. *Coll.* C. M. Weber, Jan. 28, 1909.

CAUDATA

AMBYSTOMA AMBLYCEPHALA Taylor.

Holotype.

Type. EHT-HMS, No. 16443. *Paratypes.* EHT-HMS, Nos. 16442, 16444, topotypes.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 420-21, pl. XLV, fig. 2.*Type loc.* Fifteen km. W. of Morelia [Taciúaro], Michoacán, México. *Coll.* E. H. Taylor, Sept. 10, 1938.

AMBYSTOMA BOMBYPELLA Taylor.

Holotype.

Type. EHT-HMS, No. 3997. *Paratypes.* EHT-HMS, Nos. 3998, topotype; 18896, 15 km. W. Morelia, Michoacán.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 318-320, pl. XLV, fig. 1.*Type loc.* Rancho Guadalupe, 14 km. E of San Martín (Asunción), México. *Coll.* E. H. Taylor, Aug. 4, 1932.

AMBYSTOMA FLUVINATUM Taylor.

Holotype.

Type. EHT-HMS, No. 25383. *Paratypes.* EHT-HMS, Nos. 25384-25395, all topotypes.*Publ.* Copeia, 1941, No. 3, Sept. 30, pp. 144-146, fig. 2, A. B.*Type loc.* Mojarachic, Chihuahua, México. *Coll.* Irving Knobloch, June 20, 1940.

AMBYSTOMA GRANULOSA Taylor.

Holotype.

Type. EHT-HMS, No. 29805. *Paratypes.* EHT-HMS, Nos. 29804, 24042-24044, 24045-24250, 10-12 mi. N.W. Toluca, México.*Publ.* Univ. Kansas Sci. Bull., Vol. XXX, pt. I, No. 5, May 15, 1944, pp. 57-61, pl. VIII.*Type loc.* (Km. 74) about 12 mi. N.W. of Toluca, México, México. *Colls.* E. H. Taylor and Hobart M. Smith, Sept. 10, 1939.

AMBYSTOMA LACUSTRIS Taylor and Smith.

Holotype.

Type. U. S. Nat. Mus., No. 6274 (Field No.), *Paratypes.* EHT-HMS, Nos. 22894-22910, topotypes.*Publ.* See entry 1944h, p. 174.

Type loc. Lake Zumpango, México, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Mar. 3, 1939.

AMBYSTOMA ORDINARIA Taylor. Holotype.

Type. EHT-HMS, No. 16367. *Paratypes.* EHT-HMS, Nos. 16364-16366, 16367A, 16368-16370, 16372-16382, 16384-16386, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 422-424, pl. XLVI, figs. 1-3.

Type loc. About 9,000 ft. elev. near Puerto Hondo (4 mi. W. of El Mirador), Michoacán, México. *Coll.*, E. H. Taylor, Sept. 2, 1938.

AMBYSTOMA ROSACEUM Taylor. Holotype.

Type. EHT-HMS, No. 23054. *Paratypes.* EHT-HMS, Nos. 23055-23058, all topotypes.

Publ. Copeia, 1941, No. 3, Sept. 30, pp. 143-144, fig. 1, A, B.

Type loc. Mojáachic, Chihuahua, México. *Coll.*, Irving Knobloch, June, 1939.

AMBYSTOMA SCHMIDTI Taylor. Holotype.

Type. EHT-HMS, No. 3999.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939, 1st mailing), pp. 263-264, pl. XXVI, fig. 1.

Type loc. Ten mi. E. of San Martín (Asunción) at Rancho Guadalupe, México, México. *Coll.*, E. H. Taylor, Aug. 3, 1932.

AMBYSTOMA SUBSALSUM Taylor. Holotype.

Type. EHT-HMS, No. 22139. *Paratypes.* EHT-HMS, Nos. 28357-28390, all topotypes.

Publ. Copeia, 1943, No. 3, Oct. 15, pp. 151-156, figs. 1-3.

Type loc. Lake Alchichica, Puebla, México. *Coll.*, Dyfrig McH. Forbes, 1940.

*BATRACHOSAUIROIDES DISSIMULANS Taylor and Hesse. Holotype.

Type. A. & M. College, Texas, Mus. No. 2234.

Publ. Amer. Journ. Sci. Vol. 241, Mar., 1943, pp. 185-193, fig. 1.

Type loc. Middle Miocene, 3 mi. N.W. Cold Springs, San Jacinto County, Texas, U. S. A. *Coll.*, Mrs. Claude Riley, Mar., 1938.

BOLITOGLOSSA ARBOREA Taylor. Holotype.

Type. EHT-HMS, No. 16743. *Paratypes.* EHT-HMS, Nos. 16734-16742, 16744-16756, topotypes.

Publ. Herpetologica, Vol. 2, No. 3, Mar. 25, 1941, pp. 62-65, text figs. 4, 5.

Type loc. Near Tianguistengo, Hidalgo, México. *Coll.*, E. H. Taylor, Aug. 15, 1939.

BOLITOGLOSSA CHONDROSTEGA Taylor. Holotype.

Type. EHT-HMS, No. 17304. *Paratypes.* EHT-HMS, Nos. 17282-17303, 17305-17310, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 7, Dec. 15, 1941, pp. 113-115.

Type loc. Durango, Hidalgo, México, 5,000-6,000 ft. *Coll.*, E. H. Taylor, Sept. 12, 1938.

BOLITOGLOSSA COCHRANAE Taylor.

Holotype.

Type. EHT-HMS, No. 24594. *Paratypes.* EHT-HMS, Nos. 17726-17727, 24589-24593, 24595-24599, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 343-345.

Type loc. Cerro San Felipe, Oaxaca, Oaxaca, México. *Colls.*, Richard C. Taylor and E. H. Taylor.

BOLITOGLOSSA DIMIDIATA Taylor.

Holotype.

Type. EHT-HMS, No. 17677. *Paratypes.* EHT-HMS, Nos. 17671-17676, 17678-17689, 17691-17692, 17694-17705, topotypes, and El Chico Nat. Park, Hidalgo.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 408-411, text figs. 1, 2.

Type loc. Guerrero, near Mineral del Monte, Hidalgo, México. *Coll.*, E. H. Taylor, Aug. 8, 1938.

BOLITOGLOSSA GALEANAE Taylor.

Holotype.

Type. EHT-HMS, No. 17146. *Paratypes.* EHT-HMS, Nos. 17145, 25762-25763, topotypes.

Publ. Proc. Biol. Soc., Washington, Vol. 54, July 31, 1941, pp. 83-85.

Type loc. Near Galeana, Nuevo León, México (7,000 ft. elev.). *Coll.*, Radclyffe Roberts, July 10, 1938.

[The original spelling "galaenae" is a typographical error.]

BOLITOGLOSSA LAVAE Taylor.

Holotype.

Type. EHT-HMS, No. 28937. *Paratypes.* EHT-HMS, Nos. 28930-28936, 28938-29064, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 2, No. 14, Nov. 15, 1942, pp. 295-298, pl. 27, figs. 5-6.

Type loc. Two mi. W. La Joya, Veracruz, México. *Colls.*, E. H. Taylor, Aug. 16, 1941.

BOLITOGLOSSA MELANOMOLGA Taylor.

Holotype.

Type. EHT-HMS, No. 24626.

Publ. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 81-83.

Type loc. Twenty km. N. of San Antonio Limón (Totalco), Veracruz, México. *Coll.*, E. H. Taylor, June 24, 1940.

BOLITOGLOSSA NIGROFLAVESCENS Taylor.

Holotype.

Type. U. S. Nat. Mus. No. 111169. *Paratypes.* EHT-HMS, Nos. 26784-26799, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 8, Dec. 15, 1941, pp. 150-152, pl. VIII; pl. IX, figs. 9-10.

Type loc. Cerro Ovando, 5,000-6,000 ft., Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Apr. 16, 1940.

BOLITOGLOSSA NIGROMACULATA Taylor.

Holotype.

Type. U. S. Nat. Mus., No. 110635. *Paratypes.* EHT-HMS, Nos. 24600-24621, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 8, Dec. 15, 1941, pp. 141-145.

Type loc. Cuautlapan, Veracruz. *Coll.*, Hobart M. Smith.

BOLITOGLOSSA OCCIDENTALIS Taylor.

Holotype.

Type. U. S. Nat. Mus., No. 111085. *Paratypes.* EHT-HMS, Nos. 27176-27180, topotypes; 24049, Finca Juarez, Chiapas; 26561, El Dorado, Guatemala [exc. Field Mus.].

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 8, 1941 (Dec.), pp. 145-147, text fig. 1, C.

Type loc. La Esperanza [near Escuintla], Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Apr. 28, 1940.

BOLITOGLOSSA TERRESTRIS Taylor.

Holotype.

Type. EHT-HMS, No. 23354. *Paratypes.* EHT-HMS, Nos. 17311-17359, 23244-23310, topotypes; 23311-23405.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 7, 1941 (Dec.), pp. 115-117.

Type loc. Six mi. S. Tianguistengo, Hidalgo, México (elev. 5,000 ft.). *Coll.*, E. H. Taylor, July 1, 1940.

BOLITOGLOSSA UNGUIDENTIS Taylor.

Holotype.

Type. EHT-HMS, No. 17102. *Paratypes.* EHT-HMS, Nos. 17103-17113, 17115, 17116, 15630, 15642, 15643, 16547A, 15649A, 15651, topotypes.

Publ. Herpetologica, Vol. 2, No. 3, Mar. 25, 1941, pp. 57-62, text figs. 1-3.

Type loc. Cerro San Felipe, 15 km. N. of Oaxaca, Oaxaca, México. *Coll.*, E. H. Taylor, Aug. 20, 1938.

BOLITOGLOSSA XOLOCALCAE Taylor.

Holotype

Type. U. S. Nat. Mus., No. 111371. *Paratypes.* EHT-HMS, Nos. 25311-25341, 26749-26783, 27264-27271, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 8, 1941 (Dec.), pp. 148-150, pl. VII, pl. IX, figs. 7-8.

Type loc. Cerro Ovando, between 6,000-8,000 ft., Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Apr. 16, 1940.

***LANEBATRACHUS MARTINI** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 1468.

Publ. Geol. Surv. Kansas, 1941, Report of Studies, Bull. 38, pt. 6, July 7, 1941, pp. 180-181, fig. 4, A, B.

Type loc. Edson Beds, Ogallala formation, Middle Pliocene, Sherman county, Kansas. *Coll.*, H. T. Martin.

OEDIPUS ALTAMONTANUS Taylor.

Holotype.

Type. EHT-HMS, No. 12245. *Paratype.* EHT-HMS, No. 12239, topotype.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 272-274, pl. XXV, figs. 3, 4.

Type loc. Lake Zempoala (Cempoula), Morelos, México (elev. 10,500 ft.). *Coll.*, E. H. Taylor, Aug. 6, 1936.

OEDIPUS GIGANTEUS Taylor.

Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 8435. *Paratypes.* EHT-HMS, Nos. 12040, 12085, Cofre de Perote, Veracruz. [Other paratypes 8434, 8436, 8437 in Harvard Coll. Mus. Comp. Zoöl.]

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 266-269, pl. XXVII, figs. 3, 4.

Type loc. Jalapa, Veracruz, México. *Coll.*, E. R. Dunn.

OEDIPUS MANNI Taylor.

Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 3915. *Paratypes.* EHT-HMS, Nos. 15656-15657.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 277-280, pl. XXIX, figs. 4-6.

Type loc. Guerrero, Hidalgo, México. *Coll.*, W. M. Mann.

OEDIPUS MULTIDENTATA Taylor.

Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 14812. *Paratypes.* EHT-HMS, Nos. 15658-15848, El Chico, Hidalgo.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 289-291, pl. XXIX, fig. 1.

Type loc. Alvarez (km. 53 on the Potosí and Rio Verde R.R.), San Luis Potosí, México, elev. 8,000 ft. *Coll.*, W. W. Brown.

OEDIPUS ROBERTSI Taylor.

Holotype

Type. EHT-HMS, No. 12503. *Paratypes.* EHT-HMS, Nos. 12496-12498, 12504-12505, 15600-15615, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 287-289, pl. XXVI, fig. 2.

Type loc. Nevada de Toluca (elev. 10,000-11,000 ft.), México, México. *Coll.*, H. Radclyffe Roberts, Sept. 7, 1936.

OEDIPUS SMITHI Taylor.

Holotype.

Type. EHT-HMS, No. 3966. *Paratypes.* EHT-HMS, Nos. 3965-3969, 15616-15641, topotypes. [Cerro San Luis is a spur of Cerro San Felipe (Mts.) near Oaxaca.]

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 269-272, pl. XXV, figs. 5, 6.

Type loc. Cerro San Luis, 15 mi. N.W. Oaxaca, Oaxaca, México. *Coll.*, H. M. Smith, Aug. 5, 1935.

*OGALLALABATRACHUS HORARIUM Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 1470.

Publ. Geol. Survey Kansas, 1941, Report of Studies, Bull. 38, pt. 6, July 7, 1941, pp. 181-182, figs. 7a-c.

Type loc. Ogallala formation, Middle Pliocene (Rhinceros Hill), Wallace county, Kansas. *Colls.*, David Dunkle and E. H. Taylor.

PLETHODON HARDII Taylor.

Holotype.

Type. EHT-HMS, No. 23656.

Publ. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 78-80.

Type loc. Sacramento Mountains, 9,000 ft., at Clouderoft, New México. *Coll.*, D. E. Hardy, June 29, 1940.

PSEUDOEURYCEA CEPHALICA RUBRIMEMBRIS Taylor and Smith.

Holotype.

Type. U. S. Nat. Mus., No. 110661. *Paratypes.* EHT-HMS, Nos. 12495, Minas, Viejas, Hidalgo; 23007, topotype; 29831, Zacualtipan, Hidalgo.

Publ. See entry 1944h, p. 174.

Type loc. Six km. S. Santa Anita, Hidalgo, elev. about 4,500 ft. *Colls.*, Dr. and Mrs. Hobart M. Smith

RHYACOSIREDON LEORAE Taylor.

Holotype.

Type. EHT-HMS, No. 22560. *Paratypes.* EHT-HMS, No. 22561, topotype.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. 2, No. 8, 1943 (Oct. 15), pp. 345-347, pl. XXVI, fig. 3.

Type loc. In a mountain stream near Río Frío, México, either in the state of Puebla or México. *Coll.*, Dyfrig McHattie Forbes, 1939.

RHYACOSIREDON RIVULARIS Taylor.

Holotype.

Type. EHT-HMS, No. 16388. *Paratypes.* EHT-HMS, Nos. 16387, 16389-16393, all topotypes.

Publ. Herpetologica, Vol. 1, 1940, pp. 171-176, pl. XVII.

Type loc. Thirteen km. W. Villa Victoria, México, México. *Coll.*, E. H. Taylor, Sept. 11, 1938.

RHYACOSIREDON ZEMPOALAENSIS Taylor and Smith.

Holotype.

Type. U. S. Nat. Mus., No. 116617. *Paratypes.* EHT-HMS, Nos. 22172-22190, 24630-24634, topotypes.

Publ. Sec entry 1944h, p. 174.

Type loc. Lakes of Zempoala, Morelos, México, in a nearly dry lake bed, 10,000 ft. elevation. *Coll.*, Hobart M. Smith.

SIREDON LERMAENSIS Taylor.

Holotype.

Type. EHT-HMS, No. 22578. *Paratypes.* EHT-HMS, Nos. 22586, 15436-15440, 22571-22586, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 427-430.

Type loc. Lake Lerma, E. of Toluca, México, México. *Colls.*, E. H. Taylor and H. M. Smith—purchased from fisherman—Sept. 16, 1939.

THORIUS DUBITUS Taylor.

Holotype.

Type. EHT-HMS, No. 17751. *Paratypes.* EHT-HMS, Nos. 17731-17750, 17752-17786, 22064-22084, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 7, 1941 (Dec.), pp. 107, 108-110, pl. III, fig. 3.

Type loc. Two mi. S. of Acultzingo, Veracruz, México, at summit of mountains. *Coll.*, E. H. Taylor, July 20, 1938.

THORIUS NARISOVALIS Taylor.

Holotype.

Type. EHT-HMS, No. 17859. *Paratypes.* EHT-HMS, Nos. 17794-17858, 17860-17870, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 416-418, pl. XLVII, fig. 3.

Type loc. Elevation 2,600-3,000 M. on Cerro San Felipe, 15 km. N. of Oaxaca, Oaxaca, México. *Coll.*, E. H. Taylor, Aug. 18-22, 1938.

THORIUS PULMONARIS Taylor.

Holotype.

Type. EHT-HMS, No. 16684. *Paratypes.* EHT-HMS, Nos. 16676-16683, 16685-16711, 16713-16733, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 411, 414, text figs. 3, 4.

Type loc. Cerro San Felipe about 12 km. N. of Oaxaca, Oaxaca, México. *Coll.*, E. H. Taylor, Aug. 18, 1938.

THORIUS TROGLODYTES Taylor.

Holotype.

Type. EHT-HMS, No. 17791. *Paratypes.* EHT-HMS, Nos. 12142-12143, 17789-17790, 17791A, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 7, 1941 (Dec.), pp. 110-112, pl. III, fig. 4.

Type loc. Two mi. S. Acultzingo, Veracruz, Mexico. *Coll.*, E. H. Taylor, July 10, 1938.

SALIENTIA

ACRODYTES INFLATUS Taylor.

Holotype.

Type. EHT-HMS, No. 17890. *Paratypes.* EHT-HMS, Nos. 17889, 17891, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXX, pt. I, No. 6, 1943, pp. 64-67, pl. IX.

Type loc. Near La Venta, Guerrero, México. *Coll.*, E. H. Taylor, June 27, 1938.

ACRODYTES MODESTUS Taylor and Smith.

Holotype.

Type. U. S. Nat. Mus., No. 115013.

Publ. See entry 1944h, p. 174.

Type loc. Cruz de Piedra, near Acacoyagua, Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith.

***ANCHYLORANA DUBITA** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6375.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 209-211, pl. XV, figs. 4A-4B.

Type loc. Rexroad Member, Upper Pliocene, loc. 3, about 16 mi. S. W. of Meade, Meade County, Kansas. *Coll.*, Claude W. Hibbard & party, 1938.

***ANCHYLORANA MOOREI** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6375.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 211-212, pl. XV, fig. 3A, 3B.

Type loc. Rexroad Member, Upper Pliocene, loc. 3, 16 Mi. S. W. of Meade, Meade County, Kansas. *Coll.*, Claude W. Hibbard and party, 1939.

***ANCHYLORANA ROBUSTOCONDYLA** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 5106.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 211-212, pl. XV, fig. 1.

Type loc. Rexroad Member, Upper Pliocene, loc. 3, 16 mi. S. W. of Meade, Meade County, Kansas. *Coll.*, Claude W. Hibbard and party, 1937.

BARBOURULA BUSUANGENSIS Taylor and Noble.

Holotype.

Type. Mus. Comp. Zool. Harvard College, No. 14004. Originally EHT, No. 539.

Publ. Amer. Mus. Nov., No. 121, June 23, 1924, pp. 1-4, fig. 1.

Type loc. Busuanga I., Calamian Islands, P. I. *Coll.*, E. H. Taylor, Sept. 16, 1923.

BUFO ANGUSTIPES Taylor and Smith.

Holotype.

Type. U. S. Nat. Mus., No. 116513.*Publ.* See entry 1944h, p. 174.*Type loc.* La Esperanza (near Escuintla) Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Apr. 7, 1940.***BUFO ARENARIUS** Taylor.

Holotype.

Type. Kansas Univ. Mus. Vert. Paleontology, No. 1452.*Publ.* Anal. Inst. Biol., (México), Tom. 7, No. 4, 1936, pp. 521-523; Lám. 1, figs. 2, 10-14; Lám. 2, figs. 1-2, 6, 7, 9-12.*Type loc.* Edson Beds, Ogallala, Middle Pliocene, Sherman County, Kansas. *Colls.*, H. T. Martin and Claude Hibbard, 1929.**BUFO GEMMIFER** Taylor.

Holotype.

Type. EHT-HMS, No. 18509. *Paratypes.* EHT-HMS, Nos. 18497-18508, topotypes.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 490-492, pl. LIII, figs. 3, 3a, 3b.*Type loc.* El Limoncito, near La Venta, Guerrero, México. *Coll.*, E. H. Taylor, June 29, 1938.***BUFO HIBBARDI** Taylor.

Holotype.

Type. Kansas Univ. Mus. Vert. Paleo., No. 1437.*Publ.* Anal. Inst. Biol. (México), Tom. 7, No. 4, 1936, pp. 517-521, Lám. I, figs. 3-9; Lám. II, figs. 3-4, 13-14.*Type loc.* Edson Beds, Ogallala formation, Middle Pliocene, Sherman County, Kansas. *Coll.*, Claude Hibbard, 1929.**BUFO KELLOGGI** Taylor.

Holotype.

Type. EHT-HMS, No. 21. *Paratypes.* EHT-HMS, Nos. 15-20, 22-40, topotypes.*Publ.* Univ. Kansas Sci. Bull., Vol. XXIV, No. 20, 1936 (Feb. 15, 1938), pp. 510-514, pl. XLV, figs. 1-3.*Type loc.* Two mi. E. of Mazatlán, Sinaloa, México. *Coll.*, E. H. Taylor, July 21, 1934.**BUFO MAZATLANENSIS** Taylor.

Holotype.

Type. EHT-HMS, No. 374. *Paratypes.* EHT-HMS, Nos. 373, 375-379, topotypes.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 492-494, pl. LIII, fig. 1, pl. LIV.*Type loc.* Two mi. E. Mazatlán, Sinaloa, México. *Coll.*, E. H. Taylor, July 20, 1934.**BUFO MCGREGORI** Taylor.

Holotype.

Type. California Academy of Sciences, No. 61839. Originally EHT, No. 1468A. *Paratypes.* M. C. Z. 14532-14538.*Publ.* Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 182-184, pl. 4, figs. 2-3.*Type loc.* Near Pasananka, Zamboanga Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Sept. 30, 1920.

BUFO NAYARITENSIS Taylor.

Holotype.

Type. EHT-HMS, No. 397. *Paratypes.* EHT-HMS, Nos. 380-396, 398-426, 426A, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 14, 1943, pp. 349-351, pl. XXVI, figs. 1, 1a.

Type loc. Tepic, Nayarit, México. *Coll.*, E. H. Taylor, July 28, 1934.

BUFO PERPLEXUS Taylor.

Holotype.

Type. EHT-HMS, No. 707. *Paratypes.* EHT-HMS, Nos. 682-683, 684-706, 708, 709, 708A, 813-818, 820-828, 6209-6234, 6236-6266, 6267-6271, 6273-6274, 6276, 18213-18224, 18441, 25419-25422, various localities.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 347-349, pl. XXVI, figs. 1b, 2.

Type loc. Near the edge of the Balsas river near Mexcala, Guerrero, México. *Coll.*, Hobart M. Smith and E. H. Taylor, June 24, 1932.

CENTROLENELLA VIRIDISSIMA Taylor.

Holotype.

Type. EHT-HMS, No. 27725. *Paratypes.* EHT-HMS, Nos. 27719-27724, 27726, 27727, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, May 15, 1942, pp. 75-77, pl. IX, figs. 2, 2a, 2b.

Type loc. Agua del Obispo, Guerrero, México. *Coll.*, E. H. Taylor, Aug. 2, 1941.

CHAPERINA BEYERI Taylor = *Sphenophryne fusca* Mocquard.

Holotype.

Type. Carnegie Museum, No. 3312. Originally EHT, No. 557 (Field No. 414).

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 333-335, pl. 3, fig. 3.

Type loc. Near Upper Agusan [river]; between the Agusan and Simulao rivers, probably in Davao Prov., or Agusan near the Davao-Agusan boundary. *Coll.*, E. H. Taylor, June, 1913.

CHAPERINA VISAYA Taylor.

Holotype.

Type. Bureau of Science, No. B 80.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 335-336, pl. 9, fig. 3.

Type loc. Biliran I., near Leyte, P. I. *Coll.*, Richard C. McGregor, May, 1914.

CORNUFER CORNUTUS Taylor.

Holotype.

Type. California Academy of Sciences, No. 61476. Originally EHT, No. 764.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 175-176.

Type loc. Balabalan, Kalinga, Luzon, P. I. *Coll.*, E. H. Taylor, Apr. 24, 1920.

CORNUFER LATICEPS Taylor.

Holotype.

Type. Carnegie Museum, No. 3496. Originally EHT, No. 197.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 317-318, pl. 3, fig. 1.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Sept., 1912.

CORNUFER MONTANUS Taylor.

Holotype.

Type. California Academy of Sciences, No. 61179. Originally EHT, No. 861.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 272-273, pl. 4, fig. 4.

Type loc. Mt. Banajao (1500 m. elev.), Laguna Prov., Luzon, P. I. *Coll.*, E. H. Taylor, May 31, 1920.

CORNUFER RIVULARIS Taylor.

Holotype.

Type. California Academy of Sciences, No. 61179. Originally EHT, No. 761. *Paratype.* EHT-HMS No. 29875, topotype.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 270-272, pl. 4, fig. 3.

Type loc. Balbalin, Kalinga subprov., Luzon, P. I. *Coll.*, E. H. Taylor, Apr. 25, 1920.

CORNUFER SUBTERRESTRIS Taylor.

Holotype.

Type. California Academy of Sciences, No. 61518. Originally EHT, No. 707.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 274-275.

Type loc. Km. 101 on Mountain Trail, Mountain Prov., Luzon, P. I. *Coll.*, E. H. Taylor, Apr. 17, 1920.

DIAGLENA RETICULATA Taylor.

Holotype.

Type. U.S. Nat. Mus., No. 115500.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 4, May 15, 1942, pp. 60-62, pl. IV, figs. 2, 2a, 2b; pl. V, fig. 1.

Type loc. Cerro Arenal, Oaxaca, México. *Coll.*, Thomas MacDougall, Jan. 2, 1940.

ELEUTHERODACTYLUS AVOCALIS Taylor and Smith.

Holotype.

Type. U.S.N.M., No. 116885.

Publ. Sec entry 1944h, p. 174.

Type loc. Tres Cruces, near Tehuantepec, Oaxaca, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Mar., 1940.

ELEUTHERODACTYLUS BATRACHYLUS Taylor.

Holotype.

Type. Mus. Comp. Zoöl. Harvard College, No. 9308.

Publ. Proc. New England Zoöl. Club, Vol. XVIII, Jan. 24, 1940, pp. 13-16, pls. I, II.

Type loc. Miquihuana, Tamaulipas, 80 mi. S.W. of [Cuidad] Victoria, Tamaulipas, México. *Coll.*, W. W. Brown, 1922.

ELEUTHERODACTYLUS BOLIVARI Taylor.

Holotype.

Type. EHT-HMS, No. 29564.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 14, Nov. 15, 1942, pp. 298-299, pl. 26, figs. 1-4.

Type loc. Ixtapan del Oro, México, *Coll.*, C. Bolivar Pieltain, June 11, 1940.

ELEUTHERODACTYLUS CACTORUM Taylor.

Holotype.

Type. EHT-HMS, No. 6383. *Paratypes.* EHT-HMS, Nos. 6376, 6382, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 391-394, text fig. 2.

Type loc. Km. 226, 20 mi. N.W. of Tehuacán, Puebla [near Cacaloapam], México. *Coll.*, E. H. Taylor, Aug. 30, 1936.

ELEUTHERODACTYLUS CONSPICUUS Taylor and Smith. Holotype.

Type. U. S. Nat. Mus., No. 116509. *Paratype.* EHT-HMS, No. 29807, topotype.

Publ. See entry 1944h, p. 174.

Type loc. Piedras Negras, Guatemala, practically on México-Guatemala border. *Colls.*, Dr. and Mrs. Hobart M. Smith, May 29, 1939.

ELEUTHERODACTYLUS DECORATUS Taylor. Holotype.

Type. EHT-HMS, No. 28720. *Paratype.* EHT-HMS, No. 28719, 2 mi. W. La Joya, Veracruz.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 14, Nov. 15, 1942, pp. 301-304, pl. 25, figs. 1-4; pl. 27, fig. A.

Type loc. Near Bandería, 6 mi. W. Jalapa, Veracruz, México. *Coll.*, E. H. Taylor, Aug. 16, 1941.

ELEUTHERODACTYLUS DORSOCONCOLOR Taylor. Holotype.

Type. U. S. Nat. Mus., No. 110610. *Paratype.* EHT-HMS, No. 24321.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. I, No. 8, Dec., 1941, pp. 152-154, pl. X.

Type loc. Tequeyutepec, Veracruz, México. *Coll.*, Hobart M. Smith.

ELEUTHERODACTYLUS HIDALGOENSIS Taylor. Holotype.

Type. EHT-HMS, No. 24454. *Paratype.* EHT-HMS, No. 24455, topotype.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 14, Nov. 15, 1942, pp. 299-301, pls. 25, figs. 5-8; 27, fig. 10.

Type loc. Four mi. N. of Tianguistengo, Hidalgo, México.

ELEUTHERODACTYLUS HOBARTSMITHI Taylor = *Microbatrachylus hobartsmithi* (Taylor), genotype of *Microbatrachylus* Taylor. Holotype.

Type. EHT-HMS, No. 2688. *Paratypes.* EHT-HMS, Nos. 3686, 3687, topotypes.

Publ. Trans. Kansas Acad. Sci., Vol. 39, 1936 (July 2, 1937), pp. 355-357, pl. 1, figs. 5-6.

Type loc. Near Uruapan, Michoacán, México. *Coll.*, Hobart M. Smith, July 19, 1935.

ELEUTHERODACTYLUS MACDOUGALLI Taylor. Holotype.

Type. EHT-HMS, No. 27482.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. I, No. 5, May 15, 1942, pp. 71-73, pl. VII.

Type loc. La Gloria, Oaxaca, México (N. of Nilttepec, elev. 4,500 ft.). *Coll.*, Thomas MacDougall.

ELEUTHERODACTYLUS MATUDAI Taylor. Holotype.

Type. U. S. Nat. Mus., No. 110626. *Paratypes.* EHT-HMS, Nos. 24353-24354, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. I, No. 5, Dec., 1941, pp. 154-157, pl. XI.

Type loc. Mt. Ovando, Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Apr. 16, 1940.

ELEUTHERODACTYLUS NATATOR Taylor. Holotype.

Type. EHT-HMS, No. 6373. *Paratypes.* EHT-HMS, Nos. 6371, 6372, 6374, 6375, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 394-397, pl. XXXIX, fig. 2; pl. XL.

Type loc. Tlilapam [=Cuautlapan]; Veracruz, México. *Coll.*, E. H. Taylor, Aug. 16, 1936.

ELEUTHERODACTYLUS OCCIDENTALIS Taylor. Holotype.

[*Novum nomen.* = *Borborocoetes mexicanus* Boulenger, preoccupied by *Leuiperus* (sic) *mexicanus* = *Eleutherodactylus mexicanus* (Brocchi)].

Type. (Cotypes.) Brit. Mus. Nat. Hist., Nos. 92.2.8.66-67.

Publ. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 91-92.

Type loc. Hacienda el Florencio, Zacatecas. *Coll.*, A. C. Buller.

ELEUTHERODACTYLUS PGYMAEUS Taylor [= *Microbatrachylus pygmaeus* (Taylor)]. Holotype.

Type. EHT-HMS, No. 3691.

Publ. Trans. Kansas Acad. Sci., Vol. 39, 1936 (July 2, 1937), pp. 352-354.

Type loc. One mile N. Rodriguez Clara, Veracruz. *Colls.*, E. H. Taylor and Hobart M. Smith, Sept. 7, 1935.

ELEUTHERODACTYLUS SALTATOR Taylor. Holotype.

Type. EHT-HMS, No. 24301. *Paratypes.* EHT-HMS, Nos. 24293, 24298, 24299, topotypes.

Publ. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 89-91.

Type loc. Omilteme, Guerrero, México. *Coll.*, E. H. Taylor, Aug. 2, 1940.

ELEUTHERODACTYLUS TARAHUMARAENSIS Taylor. Holotype.

Type. EHT-HMS, No. 23008.

Publ. Copeia, 1940, No. 4, Dec. 27, pp. 250-253, fig. 1.

Type loc. Mojarachic, Chihuahua, México, elev. 6,900 ft., Tarahumara Mts. *Coll.*, Irving W. Knobloch, 1939.

ELEUTHERODACTYLUS VOCALIS Taylor. Holotype.

Type. EHT-HMS, No. 5390. *Paratypes.* EHT-HMS, Nos. 6384-6389, 6391, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 401-405, pl. LXIV; text fig. 8.

Type loc. Hda. El Sabino, Uruapan, Michoacán, México. *Coll.*, Hobart M. Smith, July 25, 1936.

HAZELIA SPINOSA Taylor. Holotype & Genotype.

Type. Carnegie Museum, No. 3420. Originally EHT, No. 406.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 292-295, pl. 7, fig. 1.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Aug., 1912.

HYLA ARBORESCANDENS Taylor. Holotype.

Type. EHT-HMS, No. 3135 ♂.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 388-391, text fig. 1.

Type loc. Three km. S. W. Acultzingo, Veracruz, México. *Colls.*, E. H. Taylor and Hobart M. Smith, July 22, 1932.

HYLA ARBORICOLA Taylor.

Holotype.

Type. EHT-HMS, No. 24556. *Paratypes.* EHT-HMS, Nos. 24557-24588, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 7, 1941 (Dec.), pp. 118-119, pl. V, fig. 1.

Type loc. Elevation, about 7,000 ft., 6 mi. E. of Omilteme, Guerrero, México. *Coll.*, E. H. Taylor, Aug. 5, 1942.

HYLA BELTRANI Taylor.

Holotype.

Type. EHT-HMS, No. 29563.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 2, No. 14, Nov. 15, 1942, pp. 306-308, pl. 26, figs. 5-8.

Type loc. Tapachula, Chiapas, México. *Coll.*, A. Magaña, Aug. 1, 1941.

HYLA BROMELIANA Taylor.

Holotype.

Type. EHT-HMS, No. 16630. *Paratypes.* EHT-HMS, Nos. 16628, 16629, 16631, topotypes.

Publ. Copeia, 1939, No. 2, July 12, pp. 97-100, fig. 1.

Type loc. Near Tianguistengo, Hidalgo, México. *Colls.*, Mrs. Hazel Roberts and E. H. Taylor, Aug. 11, 1938.

HYLA CARDENASI Taylor.

Holotype.

Type. U. S. Nat. Mus., No. 84403. *Paratype.* EHT-HMS, No. 3963, near Río Frío, México.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 19, 1938 (July 10, 1939), pp. 430-432, pl. XLVII, fig. 2.

Type loc. Puebla, Puebla, México. *Coll.*, H. Ruana, Sept., 1919.

HYLA DENDROSCARTA Taylor.

Holotype.

Type. U. S. Nat. Mus., No. 108679. *Paratypes.* EHT-HMS, Nos. 23236-23256, all topotypes.

Publ. Proc. U. S. Nat. Mus., Vol. 89, No. 3093, 1940, pp. 45-47, pls. 2-3.

Type loc. Cuautlapan, Veracruz, México. *Coll.*, Hobart M. Smith, Jan. 1, 1939.

HYLA ERYTHROMMA Taylor.

Holotype.

Type. EHT-HMS, No. 5976.

Publ. Proc. Biol. Soc. Washington, Vol. 50, Apr. 21, 1937, pp. 48-50, pl. II, fig. 1.

Type loc. Agua del Obispo, Guerrero, México (Km. 350-351, México-Acapulco highway). *Coll.*, E. H. Taylor, July 23, 1936.

HYLA FORBESI Taylor.

Holotype.

Type. EHT-HMS, No. 22276.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 513-515, pl. LVIII, figs. 1, 1a., 1b.

Type loc. Mountains 3 mi. S.W. Acultzingo, Veracruz, México. *Coll.*, Dyfrig McHattie Forbes.

HYLA HAZELAE Taylor.**Holotype.***Type.* EHT-HMS, No. 16263. *Paratype*, EHT-HMS, No. 16262, *topotype*.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 385-389, text figs. 1, 2a, b.*Type loc.* Cerro San Felipe, 10 mi. N. of Oaxaca, Oaxaca, México. *Coll.*, E. H. Taylor, Aug. 22, 1938.**HYLA MELANOMMA** Taylor.**Holotype.***Type.* EHT-HMS, No. 21578. *Paratypes.* EHT-HMS, Nos. 21545-21554, 21556-21558, 21560-21578, all *topotypes*.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 508-510, pl. LVIII, figs. 1, 1a, 1b.*Type loc.* Seven mi. E. of Chilpancingo (Cuidad Bravos), Guerrero, México.*Coll.*, E. H. Taylor, Aug. 20, 1939.**HYLA PACHYDERMA** Taylor.**Holotype.***Type.* U. S. Nat. Mus., No. 115029.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 2, No. 14, Nov. 15, 1942, pp. 208-310, pl. 27, figs. 1-4.*Type loc.* Pan de Olla, south of Tezuitlán, Veracruz, México. *Coll.*, Hobart M. Smith, Mar. 22, 1940.**HYLA PINORUM** Taylor.**Holotype.***Type.* EHT-HMS, No. 5972.*Publ.* Proc. Biol. Soc. Washington, Vol. 50, Apr. 21, 1937, pp. 46-48, pl. 2, fig. 2.*Type loc.* Agua del Obispo, Guerrero, México (km. 350-351 México-Acapulco Highway). *Coll.*, E. H. Taylor, July 25, 1936.**HYLA RICKARDSI** Taylor.**Holotype.***Type.* EHT-HMS, No. 5947. *Paratypes.* EHT-HMS, Nos. 5897-5970, *topotypes*; 1431-1490, 4 mi. E. Encero, Veracruz.*Publ.* Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 385-388, pl. XLI, figs. 1-8.*Type loc.* Near Potrero Viejo, Veracruz, México. *Colls.*, Mr. and Mrs. Dyfrig McH. Forbes, and E. H. Taylor, Aug. 29, 1936.**HYLA ROBERTMERTENSI** Taylor.**Holotype.***Type.* EHT-HMS, No. 2270. *Paratypes.* EHT-HMS, Nos. 2269, 2271, Tapachula, Chs.; 2272-2280, near Tonolá, Chs.; 2290, near Asunción, Chs.*Publ.* Proc. Biol. Soc. Washington, Vol. 50, Apr. 21, 1937, pp. 43-45, pl. II, figs. 3-7.*Type loc.* Near Tapachula, Chiapas, México. *Colls.*, E. H. Taylor and Hobart M. Smith, Aug. 24, 1935.**HYLA ROBERTSORUM** Taylor.**Holotype.***Type.* EHT-HMS, No. 16264. *Paratypes.* EHT-HMS, Nos. 16265-16313, all *topotypes*.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 393-396, text figs. 5, 6.*Type loc.* El Chico National Park, Hidalgo, México. *Colls.*, Mr. and Mrs. Radelyffe Roberts, and E. H. Taylor, Aug. 7, 1938.

HYLA ROBUSTOFEMORA Taylor.

Holotype.

Type. EHT-HMS, No. 16314.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 389-393, text figs. 3, 4.*Type loc.* Cerro San Felipe, 10 mi. N. of Oaxaca, Oaxaca, México. *Coll.*, E. H. Taylor, Aug. 22, 1938.**HYLA ROZELLAE** Taylor.

Holotype.

Type. U. S. Nat. Mus., No. 115039.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, May 15, 1942, pp. 78-79, pl. IX, figs. 1, 1a-1c.*Type loc.* Salto de Agua, Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith.**HYLA SMARAGDINA** Taylor.

Holotype.

Type. EHT-HMS, No. 17534 *Paratypes.* EHT-HMS, Nos. 17526-17533, 17535-17554, topotypes*Publ.* Copeia, 1940, No. 1, Mar. 30, pp. 18-20, fig. 1.*Type loc.* Six km E. Cojumatlán, Michoacán, México. *Coll.*, E. H. Taylor, Sept., 1938**HYLA WRIGHTORUM** Taylor.

Holotype.

Type. Univ. Michigan Mus Zool., No. 79141. *Paratype.* EHT-HMS, No. 29841, topotype. [Exc. Michigan Mus Zool.]*Publ.* Univ. Kansas Sci. Bull., Vol. XXV, No. 19, 1938 (July 10, 1939), pp. 436-439, pl. XLVII, fig. 1*Type loc.* Eleven mi S. of Springerville, Apache county, Arizona, U. S. A. *Coll.* ?**HYLELLA AZTECA** Taylor.

Holotype.

Type. EHT-HMS, No. 17525.*Publ.* Proc. Biol. Soc. Washington, Vol. 56, June 16, 1943, pp. 49-52.*Type loc.* Tepoxtlán, Morelos. *Coll.*, E. H. Taylor, summer 1938.**HYPOPACHUS ALBOVENTER** Taylor.

Holotype.

Type. EHT-HMS, No. 18615 *Paratypes.* EHT-HMS, Nos. 6552-6555, near Huajintlán, Mor.; 18611-18614, 18616-18621, 2 to 8 mi. N. & E. Cuernavaca, Mor.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 522-524, pl. LX; LXIII, figs. 3, 3a.*Type loc.* Eight mi. E. of Cuernavaca, Morelos, México. *Coll.*, E. H. Taylor, June 20, 1938.**HYPOPACHUS CAPRIMIMUS** Taylor.

Holotype.

Type. EHT-HMS, No. 18149. *Paratypes.* EHT-HMS, Nos. 1024-1030, 6555-6559, 18142-18148, 18150-18154, 18158-18159, all various localities in southern Guerrero.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 526-527, pl. LXI; pl. LXIII, figs. 1, 1a.*Type loc.* Agua del Obispo, Guerrero, México. *Coll.*, E. H. Taylor, June 25, 1938.

HYPOPACHUS CUNEUS NIGRORETICULATUS Taylor. Holotype.

Type. EHT-HMS, No. 12605. *Paratypes.* EHT-HMS, Nos. 12594-12604, 12606-12690, topotypes, and localities in Campeche and Yucatán.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 518-520, pl. LIX.

Type loc. Encarnación, Campeche. México. *Coll.*, Hobart M. Smith, Oct. 1, 1936.

HYPOPACHUS MACULATUS Taylor. Holotype.

Type. EHT-HMS, No. 1023. *Paratypes.* EHT-HMS, Nos. 1016-1022, Asunción, Chs.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 524-526.

Type loc. San Ricardo, Chiapas, México. *Colls.*, E. H. Taylor and Hobart M. Smith, Sept. 2, 1935.

HYPOPACHUS OVIS Taylor. Holotype.

Type. EHT-HMS, No. 1050. *Paratypes.* EHT-HMS, Nos. 1034-1049, 1051-1093, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 520-522, pl. LVII, fig. B.

Type loc. Tepic, Nayarit, México. *Coll.*, E. H. Taylor, July 31, 1934.

KALOULA KALINGENSIS Taylor. Holotype.

Type. Originally EHT, No. 824.

Paratype. Mus. Comp. Zool. Harvard College, No. 14474.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 178-180, pl. 3, figs. 1-2.

Type loc. Balbalan, Kalinga, Mountain Prov., Luzon, P. I. *Coll.*, E. H. Taylor, Apr. 28, 1920.

KALOULA NEGROSENSIS Taylor. Holotype.

Type. California Academy of Sciences, No. 62124. Originally EHT, No. 583.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug. 1922, pp. 180-182, pl. 3, figs. 3, 4.

Type loc. Hinigaran, Negros, P. I. *Coll.*, E. H. Taylor, Apr., 1915.

KALOULA RIGIDA Taylor. Holotype.

Type. California Academy of Sciences, No. 16475. Originally EHT, No. 7681.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 176-178, pl. 3, figs. 5, 6.

Type loc. Balbalan, Kalinga, Mountain Prov., Luzon, P. I. *Coll.*, E. H. Taylor, Apr. 26, 1920.

LEPTODACTYLUS OCCIDENTALIS Taylor. Holotype.

Type. EHT-HMS, No. 3322. *Paratypes.* EHT-HMS, Nos. 3313-3321, 3323-3355, topotypes; 3310, south of Presidio, Sin.; 3311-3312, 1 to 2 mi. E. Mazatlán, Sinaloa.

Publ. Trans. Kansas Acad. Sci., Vol. 39, 1936 (1937), pp. 349-352, pl. 1, figs. 1, 2, 7.

Type loc. Tepic, Nayarit, México. *Coll.*, E. H. Taylor, July 28, 1934.

MEGALOPHRYS LIGAYAE Taylor.

Holotype.

Type. Carnegie Museum, No. A3304. Originally EHT, No. F325.*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 350-352.*Type loc.* Northern part of Palawan, P. I. *Coll.*, Victor Lednicky, May, 1918.**MEGALOPHRYS STEJNEGERI** Taylor.

Holotype.

Type. Carnegie Museum, No. 3394. Originally EHT, No. F315.*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 347-350, pl. 10, figs. 1, 1a.*Type loc.* Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Aug. 10, 1912.**MICRIXALUS DIMINUTIVA** Taylor.

Holotype.

Type. California Academy of Sciences, No. 61842. Originally EHT, No. 1066.*Publ.* Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 267-269, pl. 1, figs. 3, 4; pl. 2, figs. 2, 3.*Type loc.* Near Pasananka, Zamboanga Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Nov. 10, 1920.**MICROBATRACHYLUS ALBOLABRIS** Taylor.

Holotype.

Type. EHT-HMS, Nos. 6407. *Paratypes.* EHT-HMS, Nos. 6407A, near Córdoba; 18802, Potrero Viejo; 18803, San Juan de Gracia, Veracruz.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 502-504, pl. LVI, figs. A, B.*Type Loc.* Two mi. W. of Córdoba, Veracruz, México. *Coll.*, E. H. Taylor, Aug. 20, 1936.**MICROBATRACHYLUS IMITATOR** Taylor.

Holotype.

Type. U.S. Nat. Mus., No. 115508.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 5, May 15, 1942, pp. 70-71.*Type loc.* La Esperanza [near Escuintla], Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, May 15, 1940.**MICROBATRACHYLUS LINEATISSIMUS** Taylor.

Holotype.

Type. EHT-HMS, No. 24289. *Paratypes.* EHT-HMS, Nos. 24287, 24288, 24290, topotypes.*Publ.* Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 87-89.*Type loc.* Cerro San Felipe, between 7,000-8,000 ft. near Oaxaca, Oaxaca, México. *Colls.*, R. C. Taylor and E. H. Taylor, July, 1940.**MICROBATRACHYLUS MINIMUS** Taylor.

Holotype.

Type. EHT-HMS, No. 6416. *Paratypes.* EHT-HMS, Nos. 6411, 6413, 6415, topotypes; 3689 near Mazatlán, Guerrero.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 507-508, pl. LVI, figs. C, D.*Type loc.* Agua del Obispo (km. 350), Guerrero, México. *Coll.*, E. H. Taylor, Aug. 1, 1936.

MICROBATRACHYLUS MONTANUS Taylor.**Holotype.**

Type. U. S. Nat. Mus., No. 115507. *Paratype.* EHT-HMS, No. 27346 (S. 14311), Salto de Agua, Chiapas.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 5, May 15, 1942, pp. 67-69.

Type loc. Mt. Ovando, Chiapas, México (elev. 6,000 ft.). *Colls.*, Dr. and Mrs. Hobart M. Smith, Apr. 16, 1940.

MICROBATRACHYLUS OAXACAE Taylor.**Holotype.**

Type. EHT-HMS, No. 18197. *Paratypes.* EHT-HMS, Nos. 18188-18189, 18191-18196, 18198, 18203, 18205-18207, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 504-507.

Type loc. Cerro San Felipe, near Oaxaca, Oaxaca, México. *Coll.*, E. H. Taylor, Aug. 18-22, 1938.

MICROHYLA FOWLERI Taylor.**Holotype.**

Type. Acad. Nat. Sci. Philadelphia, No. 19903.

Publ. Proc. Acad. Nat. Sci. Philadelphia, Vol. LXXXVI, June 13, 1934, pp. 284-286, pl. 17, fig 3; text fig 1.

Type loc. Chiang Mai, Siam *Coll.*, Baron R. M. de Schauensee, Mar, 1933.

MICROHYLA MAZATLANENSIS Taylor.**Holotype.**

Type. EHT-HMS, No. 1236 *Paratypes.* EHT-HMS, Nos. 1237-1238, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 355-357

Type loc. Two mi E. Mazatlán, Sinaloa, México. *Coll.*, E. H. Taylor, July 20, 1934.

*** MIOPELODYTES GILMOREI** Taylor.**Holotype**

Type. U. S. Nat. Mus., No. 12356.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. I, No. 4, 1941 (Dec.), pp. 62-69, pl. 1; text fig. 1.

Type loc. Elko Shales, Middle Miocene, near Elko, Nevada, U. S. A. *Coll.*, W. L. Sheeler.

NECTOPHRYNE LIGHTI Taylor.**Holotype.**

Type. ——. Originally EHT, No. 189.

Publ. Philp. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 338-339, pl. 7, figs. 3, 3a.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, July, 1913.

*** NEOSCAPHIOPUS NOBLEI** Taylor.**Holotype.**

Type. Univ. Kansas Mus. Vert. Paleo., No. 6367.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, p. 204, pl. XV, figs. 5A, 5B.

Type loc. Rexroad Member formation, Upper Pliocene, Loc. 3, about 16 miles S. W. of Meade, Meade county, Kansas. *Coll.*, Claude W. Hibbard and party, 1938.

PHILAUTUS BASILANENSIS Taylor.

Holotype.

Type. California Academy of Sciences, No. 60145. Originally EHT, No. 1510.

Publ. Philip. Journ. Sci., Vol. XXI, No. 2, Aug., 1922, pp. 169-171, pl. 1, figs. 1, 2.

Type loc. Abung-Abung, Basilan I., P. I. *Coll.*, E. H. Taylor, Oct. 15, 1920.

PHILAUTUS HAZELAE Taylor.

Holotype.

Type. Carnegie Museum, No. 3427. Originally EHT, No. F293.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 298-300, pl. 3, fig. 2.

Type loc. Canlaon Volcano, Negros I., P. I. *Coll.*, E. H. Taylor, Dec. 25, 1915 (not 1916 as stated).

PHILAUTUS MONTANUS Taylor.

Holotype.

Type. Bureau of Science, No. 29.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 305-307, pl. 3, fig. 5.

Type loc. Mt. Bongao, 700 M., Bongao, near southern end of Tawitawi, Sulu Arch., P. I. *Coll.*, E. H. Taylor.

[Name preoccupied *Ixalus montanus* Günther = *Philautus glandulosus* (Jerdon). Has been renamed *R[acophorus] P[hilautus] alticola* nov. nom. Ahl. = *Philautus alticola* (Ahl) (Anura III, Das Tierreich, Lief. 55, pp. 95-96)]

PHILAUTUS POLILLENSIS Taylor.

Holotype.

Type. California Academy of Sciences, No. 62250. Originally EHT, No. 351.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 171-173, pl. 2, figs. 1-4.

Type loc. Southern end of Polillo I., P. I. *Coll.*, E. H. Taylor, July 12, 1920.

PHILAUTUS WILLIAMSI Taylor.

Holotype.

Type. California Academy of Sciences, No. 62253. Originally EHT, No. 356.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 167-169, pl. 1, figs. 3-6.

Type loc. Polillo I., P. I. *Coll.*, E. H. Taylor, Aug. 12, 1920.

PHILAUTUS ZAMBOANGENSIS Taylor.

Holotype.

Type. California Academy of Sciences, No. 61840. Originally EHT, No. 1059.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 173-175, pl. 1, fig. 7.

Type loc. "Near Pasananka," Zamboanga Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Sept. 26, 1920.

POLYPEDATES LINKI Taylor.

Holotype.

Type. California Academy of Sciences, No. 60684. Originally EHT, No. 1703.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 276-278, pl. 3, fig. 2.

Type loc. Jolo, Jolo I., P. I. *Coll.*, E. H. Taylor, Nov. 10, 1920.

PTYCHOHYLA ADIPOVENTRIS Taylor. Genotype and Holotype.*Type.* EHT-HMS, No. 21592.*Publ.* Univ. Kansas Sci. Bull., Vol. XXX, pt. 1, No. 3, 1911, p. 41-45.*Type loc.* Agua del Obispo, Guerrero, México. *Coll.*, E. H. Taylor, Aug. 31, 1939.**RANA ACANTHI** Taylor. Holotype.*Type.* California Academy of Sciences, No. 62577. Originally EHT, No. 539.*Publ.* Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 523-525, pl. 2, fig. 1.*Type loc.* Busuanga I., Calamian Islands, P. I. *Coll.*, E. H. Taylor.**RANA DUBITA** Taylor. Holotype.*Type.* Probably lost in transit to Carnegie Mus. Originally EHT, No. 1460 (Field No. 412).*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 267-268.*Type loc.* Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, June, 1913.*** RANA EPHIPIUM** Taylor. Holotype.*Type.* Univ. Kansas Mus. Vert. Paleo., No. 6370.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 214-215, pl. XIV, figs. 1A, 1B.*Type loc.* Rexroad Member, Upper Pliocene, Loc. 3, about 16 mi. S.W. of Meade, Meade county, Kansas. *Coll.*, Claude W. Hibbard and party, 1938.*** RANA FAYEAE** Taylor. Holotype.*Type.* Univ. Kansas Mus. Vert. Paleo., No. 6378.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 212-213, pl. XIV, figs. 4A, 4B.*Type loc.* Rexroad Member, Upper Pliocene, Loc. 3, about 16 mi. S.W. of Meade, Meade county, Kansas. *Coll.*, Claude W. Hibbard and party, 1938.**RANA GRANDOCULA** Taylor. Holotype.*Type.* Carnegie Museum, No. 3501. Originally EHT, No. F 334.*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 274-275, pl. 7, figs. 2, 2a.*Type loc.* Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Aug., 1912.**RANA GUERREROI** Taylor. Holotype.*Type.* Probably in Carnegie Mus. Originally EHT, No. 881. *Paratype.* Mus. Comp. Zool. Harvard Coll. No. 10482-10484.*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 255-256.*Type loc.* Baguio, Mountain Prov. Luzon, P. I. *Coll.*, E. H. Taylor, June 1, 1915.**RANA IGOROTA** Taylor. Holotype.*Type.* California Academy of Sciences, No. 61484. Originally EHT, No. F 786.*Publ.* Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 260-262, pl. 3, fig. 1.*Type loc.* Balbalan, Kalinga Subprov., Luzon, P. I. *Coll.*, E. H. Taylor, Apr. 28, 1920.

RANA LIGHTI Taylor.

Holotype.

Type. EHT-HMS, No. 29836. Originally EHT, No. 1044.*Publ.* Lingnan Sci. Journ. (Canton, China), Vol. 13, No. 2, Apr. 18, 1934, pp. 306-308.*Type loc.* Amoy, Fukien, China. *Coll.*, S. F. Light, 1922.***RANA MEADENSIS** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6376.*Publ.* Univ. Kansas Sci. Bull., Vol. XVIII, pt. II, No. 10, Nov. 15, 1942, pp. 213-214, pl. XIV, figs. 5A, 5B.*Type loc.* Rexroad Member, Upper Pliocene, Loc. 3, about 16 mi. S.W. of Meade, Meade county, Kansas. *Coll.*, Claude W. Hibbard and party, 1938.**RANA MEGAPODA** Taylor.

Holotype.

Type. EHT-HMS, No. 3280. *Paratypes.* EHT-HMS, Nos. 3271, 3272, 3272A, 3273-3279, all topotypes.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 14, Nov. 15, 1942, pp. 310-312, pl. 28, figs. 1-2.*Type loc.* Near Chapala, Jalisco, México. *Coll.*, Hobart M. Smith, July 2, 1935.**RANA MELANOMENTA** Taylor.

Holotype.

Type. Bureau of Science, No. 1661.*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 268-270.*Type loc.* Papahag, Sulu Arch., P. I. *Coll.*, E. H. Taylor, Oct. 5, 1917.**RANA MERRILLI** Taylor.

Holotype.

Type. California Academy of Sciences, No. 62448. Originally EHT, No. F 876.*Publ.* Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 164-166.*Type loc.* Burdeos, Polillo I., P. I. *Coll.*, E. H. Taylor, July 27, 1920.**RANA MICRIXALUS** Taylor.

Holotype.

Type. California Academy of Sciences, No. 60143. Originally EHT, No. 1598.*Publ.* Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 526-527, pl. 2, figs. 2, 3.*Type loc.* Abung-Abung, Basilan I., P. I. *Coll.*, E. H. Taylor, Oct. 20, 1920.**RANA MOODIEI** Taylor.

Holotype.

Type. Carnegie Museum, No. 3724. Originally EHT, No. 1240.*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 234-236, pl. 1, fig. 5.*Type loc.* Manila, P. I. *Coll.*, E. H. Taylor, Nov., 1914.**RANA PARVA** Taylor.

Holotype.

Type. Carnegie Museum, No. 3421. Originally EHT, No. F 409.*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 241-242, pl. 3, fig. 4.*Type loc.* Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Aug., 1912.

*** RANA PARVISSIMA** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6451.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, p. 217, pl. XVI, fig. 2.*Type loc.* Rexroad Member, Upper Pliocene, Loc. 3, 16 mi. S.W. of Meade, Meade county, Kansas. *Coll.*, Claude W. Hibbard and party, 1938.**RANA PHILIPPINENSIS** Taylor.

Holotype.

Type. Carnegie Museum, No. A3306. Originally EHT, No. 662.*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 266-267.*Type loc.* [Bunawan, Agusan Prov.] Mindanao, P. I. *Coll.*, E. H. Taylor, Aug. 12, 1913.*** RANA REXROADENSIS** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6369.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 215-216, pl. XIV, figs. 3A, 3B.*Type loc.* Rexroad Member, Upper Pliocene, Loc. 3, 16 mi. S.W. of Meade, Meade county, Kansas. *Coll.*, Claude W. Hibbard and party, 1938.**RANA SANCHEZI** Taylor.

Holotype.

Type. Bureau of Science, No. F 38.*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 256-259.*Type loc.* Extreme northern part of Palawan, P. I. *Coll.*, E. H. Taylor, Apr., 1918.**RANA SIERRAMADRENSIS** Taylor.

Holotype.

Type. EHT-HMS, No. 3963B. *Paratypes.* EHT-HMS, Nos. 3963A, 6566-6568, topotypes; 6565, 9 mi. S.W. Mazatlán, Guerrero.*Publ.* Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 397-399, pl. XXXIX, fig. 1.*Type loc.* Near Agua del Obispo, between Rincón and Cajones, Guerrero. *Coll.*, E. H. Taylor, July 1, 1932.**RANA SULUENSIS** Taylor.

Holotype.

Type. Bureau of Science, No. 1638.*Publ.* Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 264-266.*Type loc.* Southern end of Tawitawi I., Sulu Arch., P. I. *Coll.*, E. H. Taylor, Oct., 1918.**RANA TAFTI** Taylor.

Holotype.

Type. California Academy of Sciences, No. 61819. Originally EHT, No. 1849.*Publ.* Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 265-267.*Type loc.* Near the Pacific Coast of Luzon, on the trail between Famy, Laguna Prov., and Infanta, Tayabas Prov., Luzon, P. I. *Colls.*, Lyman H. Taft and F. X. Williams.*** RANA VALIDA** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 5133.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 216-217, pl. XIV, figs. 2A, 2B.

Type loc. Rexroad Member, Upper Pliocene, Loc. 3, 16 mi. S. W. of Meade, Meade county, Kansas. *Coll.*, Claude W. Hibbard and party, 1938.

RANA WOODWORTHII Taylor.

Holotype.

Type. California Academy of Sciences, No. 61000. Originally EHT, No. 1921. *Paratypes.* EHT-HMS Nos. 29846, 29853, 29854, topotypes; Nos. 29847-29852, 29854A, Polillo I., P. I.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 519-522, pl. 1, figs. 1, 2.

Type loc. Near Los Baños, Laguna Prov., Luzon, P. I. *Coll.*, E. H. Taylor, June 12, 1921.

RANA YAKANI Taylor.

Holotype.

Type. California Academy of Sciences, No. 60135. Originally EHT, No. 1545.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 262-264, pl. 1, fig. 1; pl. 2, fig. 1.

Type loc. Abung-Abung, Basilan I., P. I. *Coll.*, E. H. Taylor, Oct. 22, 1920.

***SCAPHIOPUS ANTIQUUS** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 1469.

Publ. Geol. Surv. Kansas, 1941, Report of Studies, Bull. 38, pt. 6, July 7, 1941, p. 184, fig. 2.

Type loc. Edson Beds, Ogallala formation, Middle Pliocene, Sherman county, Kansas. *Colls.*, David Dunkle and E. H. Taylor.

***SCAPHIOPUS DIVERSUS** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6368.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 202-203, pl. XV, figs. 2A, 2B.

Type loc. Rexroad Member, Upper Pliocene, Loc. 3, 16 mi. S. W. of Meade, Meade county, Kansas. *Colls.*, Claude W. Hibbard and party, 1938.

***SCAPHIOPUS PLIOBATRACHUS** Taylor.

Holotype.

Type. Univ. Kansas Mus. Paleo., No. 1430.

Publ. Anal. Inst. Biol. (México), Tomo 7, No. 4, 1936, pp. 515-517, Lám. 1, fig. 1.

Type loc. Edson Beds, Ogallala, Middle Pliocene, Sherman county, Kansas. *Colls.*, H. T. Martin and Claude Hibbard, 1929.

***SCAPHIOPUS STUDERI** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 1478.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 18, 1938 (July 10, 1939), pp. 408-419, pl. XLII-XLV.

Type loc. Diatomaceous marl in contact with Edson Beds, Middle Pliocene, Logan county, Kansas. *Coll.*, Frank Studer.

SYRRHOPHUS LATODACTYLUS Taylor.

Holotype.

Type. EHT-HMS, No. 6807. *Paratypes.* EHT-HMS, Nos. 6805, Sabinas Hidalgo, N. L.; 6809-6812, La Placita, 8 km. S. Jacala, Hidalgo.

Publ. Univ. Kansas Sci. Bull., XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 297-401, pl. XLIII; text fig. 7.

Type loc. Huasteca Cañon, 15 mi. W. of Monterey, Nuevo León, México. *Coll.*, E. H. Taylor, June 20, 1936.

SYRRHOPHUS MODESTUS Taylor.

Holotype.

Type. EHT-HMS, No. 3756. *Paratypes.* EHT-HMS, Nos. 3754 3755, 3757, 3758, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 2, No. 14, Nov. 15, 1942, pp. 304-306, pl. 29.

Type loc. Hacienda Paso del Rio, Colima, México. *Coll.*, Dr. Hobart M. Smith, July 8, 1935.

SYRRHOPHUS NEBULOSUS Taylor.

Holotype.

Type. EHT-HMS, No. 3774. *Paratypes.* EHT-HMS, Nos. 3759-3773; 3775-3779, various localities.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 353-355, pl. XXVII, figs 3-5.

Type loc. Near Tonalá, Chiapas, México. *Colls.*, Hobart M. Smith and E. H. Taylor, Aug. 27, 1935.

SYRRHOPUS PIPILANS Taylor.

Holotype.

Type. EHT-HMS, No. 3843. *Paratypes.* EHT-HMS, Nos. 6841-6842, 6844-6865, 6867-6872, all Guerrero, various localities.

Publ. Proc. Biol. Soc. Washington, Vol. 53, Oct. 7, 1940, pp. 95-98, pl. 1.

Type loc. Nine mi. S. of Mazatlán, Guerrero, México. *Coll.*, E. H. Taylor, July 22, 1936.

SYRRHOPOPHUS RUBRIMACULATA Taylor and Smith.

Holotype.

Type. U. S. Nat. Mus., No. 114070.

Publ. See entry 1944h, p. 174.

Type loc. La Esperanza [near Escuintla], Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, May 13, 1940.

SYRRHOPHUS SMITHI Taylor.

Holotype.

Type. U. S. Nat. Mus., No. 108594. *Paratype.* EHT-HMS, No. 23067, topotype.

Publ. Proc. U. S. Nat. Mus., Vol. 89, No. 3093, 1940, pp. 43-45, pl. 1.

Type loc. Fifteen mi. W. of Galeana, Nuevo León, México (elev. 5,200 ft.). *Coll.*, Hobart M. Smith, Oct. 13, 1939.

TOMODACTYLUS ALBOLABRIS Taylor.

Holotype.

Type. EHT-HMS, No. 29568. *Paratypes.* EHT-HMS, Nos. 6944, 6945, 29567, 29569, 29570.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 351-353.

Type loc. Agua del Obispo, Guerrero, México. (Km. 351). *Coll.*, E. H. Taylor, about Aug. 1, 1940.

TOMODACTYLUS ANGUSTIDIGITORUM Taylor.

Holotype.

Type. EHT-HMS, No 18640. *Paratypes.* EHT-HMS, Nos. 3713 near San Martín, Méx.; 18641-18648, 18650, 9 mi. W. Zacapú, Mich.; 21579-21588, 4 mi. E. Carapa, Mich.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 494-496, pl. LV, figs. 1, 1a, 1b.

Type loc. Quiroga, Michoacán, México (elev., 6,880 ft.). *Coll.*, E. H. Taylor, Sept. 5, 1938.

TOMODACTYLUS MACROTYPANUM Taylor.

Holotype.

Type. EHT-HMS, No. 6838. *Paratypes.* EHT-HMS, Nos. 6815-6837, 6839-6840, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 496-499, pl. LV, figs. 2, 2a, 2b.

Type loc. [About 8 mi.] S. of Jacala, Hidalgo, México. *Coll.*, E. H. Taylor, July 2, 1936.

REPTILIA

LACERTILIA

BRACHYMELES BOULENGERI Taylor.

Holotype.

Type. Originally EHT, No. 205.

Publ. Bureau of Sci. Publ., 17, Dec. 7, 1922, pp. 246-247, pl. 22, fig. 2.

Type loc. Polillo I., P. I. *Coll.*, E. H. Taylor, July 15, 1920.

BRACHYMELES BURKSI Taylor.

Holotype.

Type. Originally EHT, No. 700. *Paratype.* Mus. Comp. Zool. Harvard Coll., No. 26584.

Publ. Philip. Journ. Sci., Vol. X, No. 5, Sec. D, Sept., 1917, pp. 275-276, pl. 1, fig. 5, text fig. 6.

Type loc. Sumagui (Liddell Plantation), Mindoro, P. I.

BRACHYMELES ELERAE Taylor.

Holotype.

Type. Unnumbered specimen in the Museum of Santo Tomas, Manila, P. I.

Publ. Philip. Journ. Sci., Vol. XII, No. 5, Sec. D., Sept., 1917, pp. 273-275, pl. 1, fig. 4; text figs. 4, 5.

Type loc. "Filipinas." *Coll.* and date unknown.

BRACHYMELES PATHFINDERI Taylor.

Holotype.

Type. Mus. Comp. Zool. Harvard Coll., No. 26581. Originally EHT, No. 750, 3d Coll. *Paratypes.* Mus. Comp. Zool. Harvard Coll. 26582-26583.

Publ. Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 104-106.

Type loc. Glan, Cotabato Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Apr., 1923.

BRACHYMELES SULUENSIS Taylor = *Brachymeles graciles* (Fischer) (see Phil. Journ. Sci., 21, 3, 1922, 278).

Holotype.

Type. Bureau of Science, No. 1989.

Publ. Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D., Sept., 1918, pp. 254-255, text fig. 9.

Type loc. Bubuan I., Tapanan Group, Sulu Arch., P. I. *Coll.*, E. H. Taylor, Sept., 1917.

BRACHYMELES VERMIS Taylor.

Holotype.

Type. Bureau of Science, No. 1980. *Paratype.* Mus. Comp. Zool. Harvard Coll., No. 26586.

Publ. Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D., Sept., 1918, pp. 255-257, text fig. 10.

Type loc. Bubuan, Tapanan Group, Sulu Arch., P. I. *Coll.*, E. H. Taylor, Oct. 1, 1917.

BRACHYMELES WRIGHTI Taylor.

Holotype.

Type. Mus. Comp. Zool. Harvard Coll., No. 26589. Originally EHT, No. 1126.

Publ. Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 106-108.

Type loc. Trinidad Farm School, Trinidad, Benguet subprov., Luzon, P. I.
Colls., Students of the Trinidad Farm School, 1923.

CALOTES MARMORATUS SANCHEZI Taylor.

Holotype.

Type. Bureau of Science, No. 827.

Publ. Bureau of Sci. Publ. No. 17, Dec. 7, 1922, pp. 138-139, pl. II, fig. 1.

Type loc. Polillo I., P. I. *Coll.*, C. Canonizado.

***CNEMIDOPHORUS BILOBATUS** Taylor.

Holotype.

Type. Kansas Univ. Mus. Vert. Palco., No. 5079.

Publ. Geol. Surv. Kansas. 1941, Report of Studies, Bull. 38, pt. 5, July 7, 1941, pp. 167-171, figs. 1A-C, 2A-C.

Type loc. Rexroad Formation, Upper Pliocene, Loc. 2, sixteen mi. S.W. of Meade, Meade county, Kansas. *Colls.*, Claude Hibbard and party.

CNEMIDOPHORUS BURTII Taylor.

Holotype.

Type. EHT-HMS, No. 13117. Originally EHT, No. 269. *Paratypes.* EHT-HMS, Nos. 13115-13116, 13118-13121, topotypes [originally EHT Nos. 239, 268, 311, 312, 392, 442, 443].

Publ. Univ. Kansas Sci. Bull., Vol. XXIV, No. 19, 1936 (Feb. 16, 1938), pp. 475-503.

Type loc. Near La Posá, ten mi. N.W. Guaymas, Sonora, México. *Coll.*, E. H. Taylor, July 4, 1934.

DASIA GRIFFINI Taylor.

Holotype.

Type. Bureau of Science, No. 1777.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D., Mar., 1915, p. 104, pl. 1, figs. 5, 6.

Type loc. Palawan, P. I. *Coll.*, L. E. Griffin.

DIBAMUS ARGENTEUS Taylor.

Holotype.

Type. Bureau of Science, No. 1691.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 107, 108, pl. 1, figs. 11, 12.

Type loc. Butuan, Agusan Prov., Mindanao. *Coll.*, E. H. Taylor, May, 1913.

DRACO DIVERGENS Taylor.

Holotype.

Type. Acad. Nat. Sci. Philadelphia, No. 19938.

Publ. Proc. Acad. Nat. Sci. Philadelphia, Vol. LXXXVI, June 13, 1934, pp. 291-292, pl. 17, fig. 4.

Type loc. Chiang Mai, Northern Siam. *Coll.*, Baron R. M. de Schauensee, Jan. 1-Mar. 1, 1933.

EMOIA RUFICAUDA Taylor.

Holotype.

Type. Bureau of Science, No. 1778.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 98-99.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, June, 1912.

EUMECES COPEI Taylor.

Holotype.

Type. EHT-HMS, No. 29717. EHT, Field No. 3859. *Paratypes.* EHT-HMS, Nos. 10270-10296. [Formerly EHT, Field Nos. 3860-3880, 3882-3887] all topotypes.

Publ. Proc. Biol. Soc. Washington, Vol. 46, June 30, 1933, pp. 133-137, fig. (p. 137).

Type loc. Ten mi. S.E. of Asunción in the western part of the state of México. *Colls.*, E. H. Taylor and Hobart M. Smith, Aug. 4, 1932.

EUMECES GAIGEI Taylor.

Holotype.

Type. Univ. Kansas Mus. Herpetological Coll., No. 7300.

Publ. Univ. Kansas Sci. Bull., Vol. XXII, No. 11, 1935 (Nov. 15), pp. 219-223, fig. 1.

Type loc. Taos, New Mexico, U. S. A. *Coll.*, E. H. Taylor, June, 1929.

EUMECES GILBERTI RUBRICAUDATUS Taylor.

Holotype.

Type. California Academy of Sciences, No. 39002.

Publ. Univ. Kansas Sci. Bull., Vol. XXIII, No. 1, 1935 (Aug. 15, 1936), pp. 446-451, pl. 39; text figs. 72 (name incorrectly spelled), 73.

Type loc. Tehachapi Mts., California.

EUBECES INDUBITUS Taylor.

Holotype.

Type. EHT-HMS, No. 29715. Originally EHT, No. 1731. *Paratypes.* EHT-HMS, Nos. 10332-10343, topotypes; 10344-10356, near Asunción, México (all renumbered from field numbers).

Publ. Univ. Kansas Sci. Bull., Vol. XXI, No. 5, 1933 (Nov. 27, 1934), pp. 257-267, pls. XXIV, XXV.

Type loc. México-Cuernavaca highway, km. 63 (near Tres Marias), Morelos. *Colls.*, E. H. Taylor and Hobart M. Smith, July 9, 1932.

EUMECES INEXPECTATUS Taylor.

Holotype.

Type. Univ. Kansas Museum Herpetological Coll., No. 8232.

Publ. Univ. Kansas Sci. Bull., Vol. XX, No. 13, 1932 (Oct. 1, 1932), pp. 251-259, pl. XVII.

Type loc. Citrus county, Florida. *Coll.*, Dr. Charles Burt, Mar. 7, 1930.

EUMECES OCHOTERENAE Taylor.

Holotype.

Type. EHT-HMS, No. 29716. (EHT, Field No. 1015.) *Paratypes.* EHT-HMS, Nos. 10219-10228 [originally EHT, Field Nos. 1012, 1014, 1016, 1017, 1366, 1480, 1483, 1484].

Publ. Proc. Biol. Soc. Washington, Vol. 46, June 30, 1933, pp. 129-133, fig. (Original spelling *ochoteranae* is a typographical error).

Type loc. Mazatlán; "4 mi. north of Chilpancingo, Guerrero, México." In error. (The locality Mazatlán is 21 km. south of Chilpancingo by highway, about 15 km. by straight line.) *Colls.*, E. H. Taylor and Hobart M. Smith, June 26, 1932.

EUMECES PARVIAURICULATUS Taylor.

Holotype.

Type. U. S. Nat. Mus., No. 47536.

Publ. Proc. Biol. Soc. Washington, Vol. 46, Oct. 26, 1933, pp. 178-181, fig. 2.

Type loc. Near Alamos, Sonora, México. *Coll.*, E. A. Goldman, Jan. 5, 1899.

EUMECES PARVULUS Taylor.

Holotype.

Type. U. S. Nat. Mus., No. 56903.*Publ.* Proc. Biol. Soc. Washington, Vol. 46, Oct. 26, 1933, pp. 175-178, fig. 1.*Type loc.* Tepic, Nayarit, Mexico. *Coll.*, Unknown, Apr. 10, 1910.***EUMECES STRIATULUS** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 5079.*Publ.* Geol. Survey Kansas, 1941, Report of Studies, Bull. 38, pt. 5, July 7, 1941, pp. 171-172, figs. 3A-D, 4A, B.*Type loc.* Rexroad Formation, Upper Pliocene, Loc. 2, 16 mi. S.W. of Meade, Meade county, Kansas. *Colls.*, Claude W. Hibbard and party, 1938.***EUMECOIDES HIBBARDI** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 5099.*Publ.* Geol. Survey Kansas, 1941, Report of Studies, Bull. 38, pt. 5, July 7, 1941, pp. 173-174, figs. 5A-D.*Type loc.* Rexroad Formation, Upper Pliocene, Loc. 2, 16 mi. S.W. of Meade, Meade county, Kansas. *Colls.*, Claude W. Hibbard and party, 1936.***EUMECOIDES MYLOCOELUS** Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 5115.*Publ.* Geol. Survey Kansas, 1941, Report of Studies, Bull. 38, pt. 5, July 7, 1941, pp. 174-176, figs. 6A-D.*Type loc.* Rexroad Formation, Upper Pliocene, Loc. 2, 16 mi. S.W. of Meade, Meade county, Kansas. *Colls.*, Claude W. Hibbard and party, 1936.**GEKKO MINDORENSIS** Taylor.

Holotype.

Type. Carnegie Museum, No. 2098. Originally EHT, No. 499.*Publ.* Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 115-118, fig. 2.*Type loc.* Pocatil Point, Mindoro, P. I. *Coll.*, E. H. Taylor, May 4, 1916.**GEKKO PALAWANENSIS** Taylor.

Holotype.

Type. Mus. Comp. Zool. Harvard Coll., No. 26136; and paratype 26137, topotype, and EHT-HMS, Nos. 29841-29843, topotypes. Type originally EHT, No. 1467 3d Coll.*Publ.* Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 99-101.*Type loc.* Thumb Peak, Palawan I., P. I. *Coll.*, E. H. Taylor, Oct. 23, 1923.**GEKKO POROSUS** Taylor.

Holotype.

Type. California Academy of Sciences, No. 60526. Originally EHT, unnumbered.*Publ.* Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 185-187, pl. 5, fig. 2.*Type loc.* Itbayat I., Batan Ids. (Between Luzon and Formosa). *Coll.*, G. I. Lopez, Nov. 21, 1921.**GEKKO SMARAGDINUS** Taylor.

Holotype.

Type. California Academy of Sciences, No. 62336. Originally EHT, No. 260.*Paratype.* EHT-HMS, No. 29877, topotype.*Publ.* Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 187-190, pl. 5, fig. 1.*Type loc.* Polillo I., P. I. *Coll.*, E. H. Taylor, July 12, 1920.

- GYMNODACTYLUS AGUSANENSIS** Taylor. Holotype.
Type. Bureau of Science, No. R1686.
Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 90-92.
Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, June, 1913.
- GYMNODACTYLUS ANNULATUS** Taylor. Holotype.
Type. (Cotypes) Bureau of Science, R1686-1687.
Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 92-93.
Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, July, 1913.
- HEMIDACTYLUS LUZONENSIS** Taylor. Holotype.
Type. Bureau of Science, No. 1774.
Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 93-94.
Type loc. Manila, P. I. *Coll.*, Manila high school student (name not recorded); date unknown.
- HEMIPHYLLODACTYLUS INSULARIS** Taylor. Holotype.
Type. Carnegie Museum, No. 2052. Originally EHT, No. 490.
Publ. Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 237-239, pl. 1, figs. 6, 7; text fig. 4.
Type loc. Sumagui, Mindoro, P. I. *Coll.*, E. H. Taylor, May 20, 1916.
- INSULASAUROS WRIGHTI** Taylor. Holotype.
Type. Museum Comp. Zool. Harvard College, No. 26301. Originally EHT, No. 1478.
Publ. Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 103-104.
Type loc. Thumb Peak (elevation 1,000 M.) near Iwahig, Palawan I., P. I. *Coll.*, E. H. Taylor, Oct. 26, 1923.
- LEIOLOPISMA FORBESORUM** Taylor. Holotype.
Type. EHT-HMS, No. 10043. *Paratypes.* EHT-HMS, Nos. 10035-10042, 10044-10045, topotypes.
Publ. Copeia 1937, No. 1, Apr. 10, pp. 8-11.
Type loc. LaPlacita, Hidalgo, México (8 mi. S. of Jacala), elev., about 7,000. *Coll.*, E. H. Taylor, July 2, 1936.
- LEIOLOPISMA PULCHELLUM GRANDE** Taylor. Holotype.
Type. Carnegie Museum, No. 2202, and paratype 2203. Type originally EHT, No. 899.
Publ. Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 374-377.
Type loc. Canlaon Volcano, elevation, 900, Negros, P. I. *Coll.*, E. H. Taylor, Dec. 22, 1915.
- LEIOLOPISMA SILVICOLUM** Taylor. Holotype.
Type. EHT-HMS, No. 10033. *Paratype.* EHT-HMS, No. 10034, topotype.
Publ. Copeia 1937, No. 1, Apr. 10, pp. 5-7.
Type loc. Ten miles S.E. of Córdoba near San Lorenzo, Veracruz, México. *Coll.*, E. H. Taylor, Aug. 19, 1936.

LEPIDODACTYLUS AUREOLINEATUS Taylor.

Holotype.

Type. Bureau of Science, No. 1775.*Publ.* Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 97-98.*Type loc.* Bunauan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, June, 1913.**LEPIDODACTYLUS CHRISTIANI** Taylor.

Holotype.

Type. Carnegie Museum, No. 1747. Originally EHT, No. 900.*Publ.* Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 368-370, pl. II, fig. 1.*Type loc.* Mt. Canlaon [Volcano], Negros, P. I., elevation, 700 M. *Coll.*, E. H. Taylor, Dec. 23, 1915.**LEPIDODACTYLUS DIVERGENS** Taylor.

Holotype.

Type. Bureau of Science, No. 2026.*Publ.* Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 242-245, pl. 1, figs. 1-3.*Type loc.* Great Govenen I, near Basilan, P. I. *Coll.*, E. H. Taylor, Sept., 1917.**LEPIDODACTYLUS HERREI** Taylor.

Holotype.

Type. Bureau of Science, No. 480.*Publ.* Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 529-531.*Type loc.* Luzurriaga, Oriental Negros. *Coll.*, Albert C. Herre, Mar. 14, 1922.**LEPIDODACTYLUS NAUJANENSIS** Taylor.

Holotype.

Type. Carnegie Museum, No. 2050. Originally EHT, No. 2006.*Publ.* Philip Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 113-115.*Type loc.* Naujan Lake, Mindoro, P. I. *Coll.*, E. H. Taylor, Apr. 25, 1916.**LEPIDOPHYMA SYLVATICA** Taylor [= *Gaigeia sylvatica* (Taylor)]. Holotype.*Type.* EHT-HMS, No. 16259. *Paratypes.* EHT-HMS, Nos. 16260, 16261, topotypes.*Publ.* Copeia 1939, No. 3, Sept. 9, pp. 131-133, figs. 1-2.*Type loc.* Seven mi. N. of Zacualtipan, Hidalgo, México. *Coll.*, E. H. Taylor, Aug. 10, 1938.**LUPEROSAURUS COMPRESSICORPUS** Taylor.

Holotype.

Type. Bureau of Science, No. 1781.*Publ.* Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 96-97.*Type loc.* Limay, Bataan Prov., Luzon, P. I. (Collector and date unknown.)**LUPEROSAURUS JOLOENSIS** Taylor.

Holotype.

Type. Bureau of Science, No. 1872.*Publ.* Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 235-237, pl. 1, fig. 8, text fig. 3.*Type loc.* Siet Lake, Jolo, P. I. *Coll.*, E. H. Taylor, Sept. 22, 1917.

MABUYA BONTOCENSIS Taylor.

Holotype.

Type. California Academy of Sciences, No. 61331. Originally EHT, No. 696.*Publ.* Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 532-534.*Type loc.* Mountain Trail, Bontoc subprov., Luzon, P. I. *Coll.*, E. H. Taylor, April, 1920.**MABUYA ENGELI** Taylor.

Holotype.

Type. ———. Originally EHT, 577, 3d Coll. *Paratypes.* Mus. Comp. Zoöl. Harvard Coll., Nos. 26280, 26290-26300.*Publ.* Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 101-102.*Type loc.* Saub, Cotabato Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, April, 1923.**PHYLLODACTYLUS BORDAI** Taylor.

Holotype.

Type. EHT-HMS, No. 27732. *Paratypes.* EHT-HMS, Nos. 10997, 27733, topotypes; 21808, near Agua Bendita, Guerrero.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 6, May 15, 1942, pp. 93-96, 112, fig. 1*Type loc.* Six mi north of Taxco, Guerrero, México (elevation, 5,600). *Coll.*, E. H. Taylor, Aug. 26, 1941.**PHYLLODACTYLUS MAGNATUBERCULATUS** Taylor.

Holotype.

Type. EHT-HMS, No 10995.*Publ.* Univ. Kansas Sci Bull., Vol. XXVI, No. 15, 1939 (Nov. 20, 1940), pp. 547-549.*Type loc.* Acapulco, Guerrero, México. *Coll.*, Hobart M. Smith, Oct. 10, 1936.**PHYLLODACTYLUS MAGNUS** Taylor.

Holotype.

Type. EHT-HMS, No. 21783. *Paratypes.* EHT-HMS, Nos. 11035, Tonolá, Chs.; 11038-11044, 11047-11049, 21765-21771, 21784-21786, various localities in Guerrero.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. I, No. 6, May 15, 1942, pp. 99-103, fig. 3.*Type loc.* Tierra Colorada, Guerrero. *Coll.*, E. H. Taylor, Sept. 2, 1939.**PHYLLODACTYLUS MURALIS** Taylor.

Holotype.

Type. EHT-HMS, No 10902. *Paratypes.* EHT-HMS, Nos. 10883-10901, 10903-10939, topotypes; 11046, San Gerónimo, Oax. [In type description, Nos. 10993-10939 read 10903-10939.]*Publ.* Univ. Kansas Sci Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 543-547, text fig. 7.*Type loc.* Near Totolapam, Oaxaca, Oaxaca, México. *Coll.*, Hobart M. Smith, Aug. 22, 1935.**PTYCHOZOOM INTERMEDIA** Taylor.

Holotype.

Type. Bureau of Science, No. 1776.*Publ.* Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 94-96.*Type loc.* Bunauan, Agusan, Mindanao, P. I. *Coll.*, E. H. Taylor, July 12, 1912.

SIAPHOS AURICULATUM Taylor.

Holotype.

Type. Carnegie Museum, No. 1737. Originally EHT, No. 894.*Publ.* Philip. Journ. Sci., Vol. 12, No. 6, Sec. D, Nov., 1917, pp. 377-378, pl. II, fig. 2.*Type loc.* Canlaon Volcano, elevation, 900 M., Negros I., P. I. *Coll.*, E. H. Taylor, Dec. 23, 1915.**SIAPHOS HERREI** Taylor.

Holotype.

Type. California Academy of Sciences, No. 62262. Originally EHT, No. 208.*Publ.* Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 194-196, pl. 7, fig. 1.*Type loc.* Polillo I., P. I. *Coll.*, E. H. Taylor, July, 1920.**SIAPHOS KEMPI** Taylor.

Holotype.

Type. Carnegie Museum, No. 1734. Originally EHT, No. 2016.*Publ.* Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 118-120, text fig. 3.*Type loc.* Naujan Lake, Mindoro, P. I. *Coll.*, E. H. Taylor, Apr. 23, 1916.**SPHENOMORPHUS ARBOREUS** Taylor.

Holotype.

Type. Carnegie Museum, No. 1891. Originally EHT, No. 413.*Publ.* Philip. Journ. Sci., Vol. 12, No. 6, Nov., 1917, pp. 373-374, pl. 1.*Type loc.* Mt. Canlaon [Volcano], Negros I., P. I. *Coll.*, E. H. Taylor, Dec. 20, 1915.**SPHENOMORPHUS BAKERI** Taylor.

Holotype.

Type. California Academy of Sciences, No. 61330. Originally EHT, unnumbered.*Publ.* Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 193-194.*Type loc.* Haight's Place, Pauai, Benguet, Mountain Prov., Luzon, P. I. *Coll.*, Charles Fuller Baker, Apr., 1921.**SPHENOMORPHUS BEYERI** Taylor.

Holotype.

Type. California Academy of Sciences, No. 61183. Originally EHT, No. 17.*Publ.* Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 283-285.*Type loc.* Mt. Banajao (elev., about 1,500 M.) Laguna Prov., Luzon, P. I. *Coll.*, E. H. Taylor, May 31, 1920.**SPHENOMORPHUS BIPARIETALIS** Taylor.

Holotype.

Type. [Erroneously stated to be in EHT Coll.] Bureau of Science, Manila, P. I., No. 1991. *Paratypes.* In Mus. of Comp. Zool. Harvard Coll. Nos. 20439, 26384-26385.*Publ.* Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 249-251, text fig. 7.*Type loc.* Lapac I., Sulu Islands, P. I. *Coll.*, E. H. Taylor, Sept. 28, 1917.**SPHENOMORPHUS COXI** Taylor.

Holotype.

Type. Bureau of Science, No. 1782.*Publ.* Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 100-101, pl. 1, figs. 1, 2.*Type loc.* Bunauan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, June, 1912.**SPHENOMORPHUS CURTIROSTRIS** Taylor.

Holotype.

Type. Bureau of Science, No. R1695.*Publ.* Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 101-102.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Sept. 8, 1912.

SPHENOMORPHUS JAGORII DIVERGENS Taylor. Cotypes.

Type. (Cotypes) EHT-HMS, Nos. 29837-29840, Calapan, Mindoro. Originally EHT, Nos. 966, 1001, 1002, 2348. Carnegie Museum, Nos. 1761-1766, 1767-1774, 1776, 1778.

Publ. Bureau of Sci. Publ. 17, Dec. 7, 1922, p. 194.

Type loc. Mt. Maquiling, Luzon; Naujan, Mindoro; Sumagui, Mindoro; from Calapan, Mindoro. *Coll.*, E. H. Taylor, various dates.

SPHENOMORPHUS JAGORII GRANDIS Taylor. Holotype.

Type. Carnegie Museum, No. 1722. Originally EHT, No. 1414.

Publ. Bureau of Sci. Manila, Publ. 17, Dec. 7, 1922, pp. 195-196, fig. 28.

Type loc. Canlaon Volcano, Negros I., P. I. *Coll.*, E. H. Taylor, Dec. 25, 1915.

SPHENOMORPHUS LEDNICKYI Taylor. Holotype.

Type. Carnegie Museum, No. 2643. Originally EHT, No. 1992.

Publ. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 120-121, text fig. 4.

Type loc. Masbate I., P. I. *Coll.*, Victor E. Lednicky, June, 1917.

SPHENOMORPHUS LLANOSI Taylor. Holotype.

Type. Unnumbered specimen in the Santo Tomás Museum, Manila, P. I.

Publ. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 121-123, pl. II.

Type loc. "Probably from Luzon." Collector and date unknown.

SPHENOMORPHUS MINDANENSIS Taylor. Holotype.

Type. Bureau of Science, No. 1690.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 99-100, pl. 1, figs. 1, 2.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Sept., 1912.

SPHENOMORPHUS PALUSTRIS Taylor. Holotype.

Type. Bureau of Science, No. 1687.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 102-104.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Sept. 16, 1912.

SPHENOMORPHUS STEJNEGERI Taylor. Holotype.

Type. California Academy of Sciences, No. 61182. Originally EHT, No. 16.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 537-538.

Type loc. Mt. Banajao, Laguna Prov., Luzon, P. I. *Coll.*, E. H. Taylor, May 30, 1920.

TROPIDOPHORUS RIVULARIS Taylor. Holotype.

Type. Bureau of Science, No. 1780.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 106-107, figs. 9, 10.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, June, 1912.

TROPIDOPHORUS STEJNEGERI Taylor.**Holotype.**

Type. California Academy of Sciences, No. 60230. Originally EHT, No. 1538.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 285-287 pl. 4, fig. 1.

Type loc. Abung-Abung, Basilan I., P. I. *Coll.*, E. H. Taylor, Oct. 22, 1920.

SERPENTES**ANOMALEPIS ASPINOSUS** Taylor.**Holotype.**

Type. Mus. Comp. Zoöl. Harvard Coll., No. 14782.

Publ. Proc. New England Zoöl. Club, Vol. XVII, June 26, 1939, pp. 92-93, pl. V, figs. 4-7.

Type loc. Perico, Perú. *Coll.*, G. K. Noble.

ANOMALEPIS DENTATUS Taylor.**Holotype.**

Type. Mus. Comp. Zoöl. Harvard Coll., No. 29220.

Publ. Proc. New England Zoöl. Club, Vol. XVII, June 26, 1939, pp. 90-91, pl. V, figs. 1-3.

Type loc. Barro Colorado, Canal Zone. *Coll.*, James Zetek (recently E. R. Dunn claims to have collected the specimen; but on the invoice of specimens sent from Harvard, James Zetek is named collector).

BOIGA DENDROPHILA DIVERGENS Taylor.**Holotype.**

Type. Carnegie Museum, No. 2143. Originally EHT, No. 186.

Publ. Bureau of Sci. Manila Publ. No. 16, Feb. 11, 1922, pp. 201-203.

Type loc. Mt Maquiling, Laguna Prov., Luzon, P. I. *Coll.*, E. H. Taylor, Nov. 12, 1913.

BOIGA SCHULTZEI Taylor.**Cotype.**

Type. (Cotypes) Unnumbered spec. Willie Schultze, Manila, P. I., Collection; and Museum Comp. Zoöl. Harvard Coll., No. 25791.

Publ. Philip. Journ. Sci. Vol. 22, No. 5, May, 1923, pp. 552-553, pl. 3, fig. 3.

Type loc. Palawan, P. I. *Coll.*, C. M. Weber.

CALAMARIA GERVAISII IRIDESCENS Taylor.**Holotype.**

Type. Carnegie Museum, No. 8806. Originally EHT, No. 201.

Publ. Philip. Journ. Sci., Vol. XII, No. 6, Sec. D., Nov., 1917, pp. 360-362.

Type loc. Canlaon Volcano, Negros I., elevation, 900 M. *Coll.*, E. H. Taylor, Dec. [23-25], 1915.

CALAMARIA HOLLANDI Taylor.**Holotype.**

Type. California Academy of Sciences, No. 60471. Originally EHT, No. 1255.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 550-552.

Type loc. Port Holland, Basilan, P. I. *Coll.*, E. H. Taylor, Oct., 1920.

CALAMARIA JOLOENSIS Taylor.**Holotype.**

Type. California Academy of Sciences, No. 60901. Originally EHT, No. 1855.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 203-204, pl. 7, figs. 2, 3.

Type loc. Central part of Jolo I., Sulu Arch., P. I. *Coll.*, E. H. Taylor, Oct. 30, 1920.

CALAMARIA POLILLENSIS Taylor.

. Holotype.

Type. California Academy of Sciences, No. 62455. Originally EHT, No. 341A.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 549-550.

Type loc. Polillo, Polillo I., P. I. *Coll.*, E. H. Taylor, July, 1921.

CALAMARIA SULUENSIS Taylor.

Holotype.

Type. Bureau of Science, No. 1837.

Publ. Bureau of Science Manila Publ. No. 16, Feb. 11, 1922, pp. 189-190.

Type loc. Cagayan, Sulu I., P. I. *Coll.*, E. H. Taylor, Nov., 1917.

CALAMARIA TROPICA Taylor.

Holotype.

Type. California Academy of Sciences, No. 62069. Originally EHT, No. 1255.

Publ. Bureau of Sci. Manila Publ. No. 16, Feb. 11, 1922, pp. 194-195.

Type loc. Coastal mountains near Naujan, Mindoro, P. I. *Coll.*, E. H. Taylor, May 2, 1916.

CONOPSIS BISERIALIS Taylor and Smith.

Holotype.

Type. EHT-HMS, No. 23648. *Paratypes.* EHT-HMS, Nos. 16244-16245, 21488, 23647-23648, 23696-23697, topotypes; 4702, 4757-4759, 4759A, 4760-4762, 5313, 15 mi. S.E. Zitácuaro, Mich.; 4708-4719, 4721, 5091A, 5092-5101, 5101A, 5102-5108, 5300, 23635, near Tres Cumbres, Morelos.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 15, Nov. 15, 1942, pp. 333-337, pl. XXXI, fig. 1; pl. XXXV, fig. 9; text figs. 2-3.

Type loc. Ten mi. W. of Villa Victoria, México, México. *Coll.*, E. H. Taylor, 1940.

CROTALUS SEMICORNUTUS Taylor.

Holotype.

Type. EHT-HMS, No. 23014.

Publ. Univ. Kansas Sci. Bull., Vol. XXX, pt. I, No. 4, pp. 52-55, pl. VII.

Type loc. Mojárichic, Chihuahua, México. *Coll.*, Irving Knobloch, 1939.

CROTALUS TRANSVERSUS Taylor.

Holotype.

Type. EHT-HMS, No. 30001. *Paratype.* EHT-HMS, No. 15879.

Publ. Univ. Kansas Sci. Bull., Vol. XXX, pt. I, No. 4, pp. 47-52, pl. VI.

Type loc. "55 km. S.W. México (city) near Tres Marias (Tres Cumbres), Morelos. *Coll.*, E. Powell, Aug., 1942.

CROTALUS TRISERIATUS GLOYDI Taylor.

Holotype.

Type. EHT-HMS, No. 23645.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. I, No. 7, 1941 (Dec. 30), pp. 130-132, text fig. 7.

Type loc. Cerro San Felipe (elev., 10,000 ft.) near Oaxaca, Oaxaca, México. *Coll.*, E. H. Taylor, 1940.

CYCLOCORUS NUCHALIS Taylor.

Holotype.

Type. California Academy of Sciences, No. 62558. Originally EHT, No. 1428.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 543-545, pl. 3, fig. 1-2.

Type loc. Pasananka, Zamboanga Prov., Mindanao, P. I. *Coll.*, E. H. Taylor.

DRYOCALAMUS McCroryi Taylor.

Holotype.

Type. California Academy of Sciences, No. 60346. Originally EHT, No. 1517.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 197-199, pl. 6, figs. 1-3.

Type loc. Abung-Abung, Basilan I., P. I. *Coll.*, E. H. Taylor, Oct. 23, 1920.

DRYOPHIS GRISEUS Taylor.

Holotype.

Type. Bureau of Science, No. 271.

Publ. Bureau of Science Manila Publ. No. 16, Feb. 11, 1922, pp. 221-222.

Type loc. Camiguin I., Cagayan Islands, P. I. *Coll.*, R. C. McGregor, 1907.

DRYOPHIS PRAEOULARIS Taylor.

Holotype.

Type. Carnegie Museum, No. 2617. Originally EHT, No. 408.

Publ. Bureau of Sci. Manila Publ., 16, Feb. 11, 1922, pp. 222-224, pl. 28, text fig. 19.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Mar. 12, 1913.

FICIMIA DESERTORUM Taylor [= *Gyalopion desertorum* (Taylor)].

Holotype.

Type. EHT-HMS, No. 4576 (originally EHT, Field No. 385).

Publ. Proc. Biol. Soc. Washington, Vol. 49, May 1, 1936, pp. 51-52.

Type loc. Twelve km. N.W. of Guaymas, Sonora. *Coll.*, E. H. Taylor, July 6, 1934.

FICIMIA RUSPATOR Smith and Taylor.

Holotype.

Type. EHT-HMS, No. 23646.

Publ. Journ. Washington Acad. Sci., Vol. 31, No. 8, Aug. 15, 1941, pp. 364-365, figs. 5, 10, 12.

Type loc. Three mi. E. of Tixtla (about ten mi. E. of Chilpancingo), Guerrero, México. *Coll.*, E. H. Taylor, July 29, 1940.

FICIMIA STRECKERI Taylor.

Holotype.

Type. Univ. Kansas Mus. Herpetological Coll., No. 4140.

Publ. Copeia 1931, No. 1 (Mar. 31), pp. 5-7.

Type loc. Three mi. E. Rio Grande City, Texas. *Coll.*, E. H. Taylor, July 13, 1940.

GEOPHIS BLANCHARDI Taylor and Smith.

Holotype.

Type. EHT-HMS, No. 5194. *Paratypes.* EHT-HMS, Nos. 5479-5483.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 13, 1938 (July 10, 1939), pp. 245-247, text figs. 2, a-d.

Type loc. About two mi. S.W. Acultzingo, Veracruz, México. *Coll.*, E. H. Taylor, Aug. 14, 1936.

GEOPHIS MACULIFERA Taylor.

Holotype.

Type. EHT-HMS, No. 23552.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. I. No. 7, 1941 (Dec. 30), pp. 119-121, text fig. 1.

Type loc. On the Húetamo Road, near the village of Cicio, Michoacán, México. *Coll.*, E. H. Taylor, Aug. 5, 1940.

HEMIBUNGARUS MCCLUNGI Taylor.

Holotype.

Type. Bureau of Science, No. 24.*Publ.* Bureau of Sci. Manila Publ. No. 16, Feb. 11, 1922, pp. 272-273, pl. 33, fig. 3; pl. 34, figs. 3, 4.*Type loc.* Polillo I., P. I. *Coll.*, C. Canonizado, Oct., 1909.**HOLARCHUS BURKSI** Taylor.

Holotype.

Type. Carnegie Museum, No. 2575. Originally EHT, No. 200.*Publ.* Philip Journ. Sci., Vol. XIII, No. 6, Sec. D, Nov., 1918, pp. 365-367.*Type loc.* Sumagui, Mindoro, P. I. *Coll.*, Clark Burks, Dec., 1916.**HOLARCHUS MACULATUS** Taylor.

Holotype.

Type. Carnegie Museum, No. 2517. Originally EHT, No. 40.*Publ.* Philip. Journ. Sci., Vol. XIII, No. 6, Sec. D, Nov., 1918, pp. 364-365, pl. 1.*Type loc.* Bunawan, Agusan, Mindanao, P. I. (Two spellings of town: Bunauan, Bunawan.) *Coll.*, E. H. Taylor, Aug., 1912.**HOLARCHUS PERKINSI** Taylor.

Holotype.

Type. Mus. Comp. Zool. Harvard College, No. 25725. Originally EHT, No. 1164.*Publ.* Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 108-109.*Type loc.* Culion, Culion I., Calamianes group, P. I. *Coll.*, Granville A. Perkins, Sept., 1923.**HYP SIGLENA TORQUATA DUNKLEI** Taylor.

Holotype.

Type. Mus. Comp. Zool. Harvard Coll., No. 42594.*Publ.* Univ. Kansas Sci. Bull., Vol. XXV, No. 16, 1938 (July 10, 1939), pp. 374-375.*Type loc.* Hda. La Clementina near Forlón, Tamaulipas, México. *Coll.*, David Dunkle, Aug. 10, 1934.**LAMPROPELTIS KNOBLOCHI** Taylor.

Holotype.

Type. EHT-HMS, No. 23017. *Paratype.* EHT-HMS, No. 23016, topotype.*Publ.* Copeia, 1940, No. 4, Dec. 27, pp. 253-255, text figs. 1, 2.*Type loc.* Mojárichic, Chihuahua, México. *Coll.*, Irving Knobloch, 1939.**LEPTODEIRA BRESSONI** Taylor.

Holotype.

Type. EHT-HMS, No. 5172. *Paratypes.* EHT-HMS, Nos. 4617, 5173, topotypes; 4619, Quesería, Col.*Publ.* Univ. Kansas Sci. Bull., Vol. XXV, No. 15, 1938 (July 10, 1939), pp. 321-325, pl. XXXI, fig. 4; pl. XXXIII, fig. 4; text fig. 2.*Type loc.* Hda. El Sabino, 20 mi. S. Uruapan, Michoacán, México. *Coll.*, Don Julio Raymond Bresson.**LEPTODEIRA SMITHI** Taylor.

Holotype.

Type. EHT-HMS, No. 5187. *Paratypes.* EHT-HMS, Nos. 4633, 5186, 5188, all topotypes.*Publ.* Univ. Kansas Sci. Bull., Vol. XXV, No. 15, 1938 (July 10, 1939), pp. 334-336, pl. XXXI, fig. 2.*Type loc.* Hda. El Sabino, 19 mi. S. of Uruapan, Michoacán, México. *Coll.*, Hobart M. Smith, Aug. 2, 1936.

LEPTOTYPHLOPS ATER Taylor.**Holotype.***Type.* U. S. Nat. Mus., No. 79957.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 536-538, text fig. 4.*Type loc.* Managua, Nicaragua, C. A. *Coll.*, H. C. Kellers.**LEPTOTYPHLOPS BRESSONI** Taylor.**Holotype.***Type.* EHT-HMS, No. 5247.*Publ.* Copeia, 1939, No. 1, Mar. 9, pp. 5-7, pl. 1, figs. 7-8.*Type loc.* Hda. El Sabino, Urupuan, Michoacán, México. *Coll.*, Don Julio Bresson.**LEPTOTYPHLOPS MAGNAMACULATA** Taylor.**Holotype.***Type.* U. S. Nat. Mus., No. 54760.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 532-533, text fig. 1.*Type loc.* Utila Id., Honduras, C. A. *Coll.*, F. J. Dyer.**LEPTOTYPHLOPS NASALIS** Taylor.**Holotype.***Type.* U. S. Nat. Mus., No. 16134.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 535-536, text fig. 3.*Type loc.* Managua, Nicaragua, C. A. *Coll.* ———.**LEPTOTYPHLOPS RUFIDORSUM** Taylor.**Holotype.***Type.* U. S. Nat. Mus., No. 49993.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 533-535, text fig. 2.*Type loc.* Lima, Perú. *Coll.*, Townsend.**NAJA NAJA PHILIPPINENSIS** Taylor.**Holotype.***Type.* Bureau of Science, No. 7.*Publ.* Bureau of Sci. Manila, Publ. No. 16, Feb. 11, 1922, pp. 265-268.*Type loc.* "Collected in Manila." *Coll.*, C. Canonizado, date ———.**NATRIX BARBOURI** Taylor.**Holotype.***Type.* California Academy of Sciences, No. 61552. Originally EHT, No. 939.*Publ.* Philip. Journ. Sci. Vol. 21, No. 3, Sept., 1922, pp. 291-293.*Type loc.* Balbalan, Kalinga subprov., Luzon, P. I. *Coll.*, E. H. Taylor, April 26, 1920.**NATRIX DENDROPHIOPS NEGROSENSIS** Taylor.**Holotype.***Type.* Carnegie Museum, No. 2261. Originally EHT, No. 128.*Publ.* Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 356-358, text fig. 1.*Type loc.* Canlaon Volcano, Negros I, P. I. *Coll.*, E. H. Taylor, 1915.**NATRIX DESCHAUENSEE** Taylor.**Holotype.***Type.* Acad. Nat. Sci. Philadelphia, No. 19927.*Publ.* Proc. Acad. Nat. Sci. Philadelphia, Vol. LXXXVI, June 13, 1934, pp. 300-302.*Type loc.* Chiang Mai, North Siam. *Coll.*, Baron R. M. de Schauensee, between Jan. 1 — Mar. 1, 1933.

ONYBELIS POTOSIENSIS Taylor.

Holotype.

Type. EHT-HMS, No. 23614 ♀.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 7, 1941 (Dec.), pp. 128-130, pl. VI, figs. 4, 5, 6.*Type loc.* Thirty-eight km. N.W. of Ciudad Maiz, San Luis Potosí, México (km. 192). *Coll.*, E. H. Taylor, Sept. 7, 1940.

PSEUDOFICIMIA PULCHERRIMA Taylor and Smith.

Holotype.

Type. EHT-HMS, No. 5497.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 12, Nov. 15, 1942, pp. 246-249, pl. 21, fig. 2; text figs. 3, 4.*Type loc.* Huajmtlán, Morelos, México. *Coll.*, E. H. Taylor, 1938.

PSEUDORHABDIUM McNAMARAE Taylor.

Holotype.

Type. Carnegie Museum, No. 2606. Originally, EHT No. 196.*Publ.* Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 363-364, 365, text fig. 2.*Type loc.* Canlaon Volcano, 900 M., Occidental Negros, P. I. *Coll.*, E. H. Taylor, Dec. 24, 1915.

PSEUDORHABDIUM MINUTUM Taylor.

Holotype.

Type. California Academy of Sciences, No. 61544. Originally EHT, F 772.*Publ.* Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 200-202, pl. 7, figs. 4, 5.*Type loc.* Balaban, Kalinga, Mountain Prov., Luzon, P. I. *Coll.*, E. H. Taylor, April 25, 1920.

SCAPHIODONTOPHIS ALBONUCHALIS Taylor and Smith.

Holotype.

Type. U. S. Nat. Mus., No. 110413. EHT-HMS, No. 23881, topotype.*Publ.* Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 6, Oct. 15, 1943, pp. 323-327, pl. XXIII, fig. 1; XXIV, XXV, figs. 1, 2; text figs. 1, 9.*Type loc.* La Esperanza (near Esecuintla), Chiapas, México. *Coll.*, Hobart M. Smith, April 23, 1940.

SCAPHIODONTOPHIS CARPICINCTUS Taylor and Smith.

Holotype.

Type. U. S. Nat. Mus., No. 110411.*Publ.* Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 6, Oct. 15, 1943, pp. 315-317, pl. XXII, fig. 1; text fig. 6.*Type loc.* Piedras Negras, Guatemala, C. A. *Coll.*, Hobart M. Smith, June 3, 1939.

SCAPHIODONTOPHIS CYCLURUS Taylor and Smith.

Holotype.

Type. EHT-HMS, No. 23618.*Publ.* Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 6, Oct. 15, 1943, pp. 318-320, pl. XXII, fig. 2; text fig. 7.*Type loc.* Cuautlapan, Veracruz, México. *Coll.*, E. H. Taylor, June, 1940.

SCAPHIODONTOPHIS NOTHUS Taylor and Smith.

Holotype.

Type. U. S. Nat. Mus., No. 110412.*Publ.* Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 6, Oct. 15, 1943, pp. 320-321, pl. XXIII, fig. 2; text fig. 8.*Type loc.* Potrero Viejo, Veracruz, México. *Coll.*, Dyfrig McH. Forbes, March 5, 1932.

SONORA ERYTHRURA Taylor. [= *Sonora michoacanensis* Duges].

Holotype.

Type. EHT-HMS, No. 5440.*Publ.* Herpetologica, Vol. 1, July 15, 1937, pp. 69-71, pl. 1, fig. 1.*Type loc.* Ten mi. S. of Taxco, Guerrero, México. *Coll.*, E. H. Taylor, July 17, 1936.

STORERIA HIDALGOENSIS Taylor.

Holotype.

Type. EHT-HMS, No. 16145.*Publ.* Herpetologica, Vol. 2, No. 4, July 15, 1942, pp. 78-79.*Type loc.* Near Zacualtipan, Hidalgo, México. *Coll.*, E. H. Taylor, Aug. 13, 1938.TANTILLA BREVISSIMA Taylor [= *Tantillita brevissima* (Taylor)].

Holotype.

Type. EHT-HMS, No. 4557.*Publ.* Trans. Kansas Acad. Sci., Vol. 39, 1936 (1937), pp. 344-345, fig. 4, a-c.*Type loc.* Top of low mountain near the city of Tonalá, Chiapas, México. *Coll.*, E. H. Taylor, 1935.

TANTILLA HOBARTSMITHI Taylor.

Holotype.

Type. EHT-HMS, No. 4558.*Publ.* Trans. Kansas Acad. Sci., Vol. 39, 1936 (1937), pp. 340-342, fig. 2, a-c.*Type loc.* LaPosa, 10 mi. N.W. of Guaymas, Sonora, México. *Coll.*, E. H. Taylor, July 3, 1934.

TANTILLA MARTINDELCAMPOI Taylor.

Holotype.

Type. EHT-HMS, No. 4550.*Publ.* Trans. Kansas Acad. Sci., Vol. 39, 1936 (1937), pp. 347-348, fig. 6, a-c.*Type loc.* Near El Treinta, Guerrero, on México-Acapulco highway. *Coll.*, E. H. Taylor, June 29, 1932.THAMNOPHIS EBURATUS Taylor = *Thamnophis chrysocephalus* (Cope).

Holotype.

Type. EHT-HMS, No. 5556.*Publ.* Herpetologica, Vol. 1, 1940, pp. 187-189, pl. XIX, lower fig.; text fig. 2.*Type loc.* Cerro San Felipe, Oaxaca, Oaxaca, México. *Colls.*, Mrs. Hazel Roberts and E. H. Taylor.THAMNOPHIS HALOPHILUS Taylor. [= *Thamnophis phenax halophilus* (Taylor).] Holotype.*Type.* EHT-HMS, No. 5560.*Publ.* Herpetologica, Vol. I, 1940, pp. 183-187, pl. XIX (upper fig.); text fig. 1.*Type loc.* Seven km. N. of Zacualtipan, Hidalgo, México. *Coll.*, E. H. Taylor, Aug. 12, 1938.

TOLUCA CONICA Taylor and Smith.

Holotype.

Type. EHT-HMS, No. 27517. *Paratypes.* EHT-HMS, Nos. 23638, 23639, Omilteme, Guerrero.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 15, 1942, pp. 340-343, pl. XXXIV, fig. 1; text fig. 5.*Type loc.* San Juan Guivini, Oaxaca, Oaxaca, México. *Coll.*, Thomas McDougall, Jan., 1941.

TOLUCA MEGALODON Taylor and Smith.

Holotype.

Type. EHT-HMS, No. 23640.*Publ.* Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 15, 1942, pp. 338-340, pls. XXX, fig. 1; XXXV, fig. 1, text fig. 4.*Type loc.* Summit Cerro San Felipe, Oaxaca, Oaxaca, México. *Coll.*, E. H. Taylor, July 10-20, 1942.

TRIMERESURUS MCGREGORI Taylor.

Holotype.

Type. Bureau of Science, No. 738.*Publ.* Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 110-112, text fig. 1.*Type loc.* Batan Island, Batanes Group (lying between Luzon and Formosa.) *Coll.*, Richard C. McGregor, June 12, 1907.

TRIMERESURUS WAGLERI ALBOVIRIDIS Taylor.

Holotype.

Type. Carnegie Museum, No. 2433. Originally EHT, No. 432.*Publ.* Philip. Journ. Sci., Vol. 12, No. 6, Sec. D, Nov., 1917, pp. 366-367.*Type loc.* Isabela, Occidental Negros, P. I. *Coll.*, E. H. Taylor, Sept. 12, 1915.

TRIMOPHODON PAUCIMACULATA Taylor.

Holotype.

Type. EHT-HMS, No. 709 (?).*Publ.* Univ. Kansas Sci. Bull., Vol. XXIV, No. 20, 1936 (Feb. 15, 1938), pp. 527-529, pl. XLVI, fig. 1.*Type loc.* Mazatlán, Sinaloa, México. *Coll.*, E. H. Taylor, July 24, 1934.

TYPHLOGEOPHIS ATER Taylor.

Holotype.

Type. California Academy of Sciences, No. 62043. Originally EHT, No. 1103.*Publ.* Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 202-203, pl. 7, figs. 6, 7.*Type loc.* Near Pasananka, Zamboanga, Mindanao, P. I.

TYPHLOPS CANLAONENSIS Taylor.

Holotype.

Type. Carnegie Museum, No. 2666. Originally EHT, No. 241.*Publ.* Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 354-355.*Type loc.* Canlaon Volcano, Negros I., P. I. *Coll.*, E. H. Taylor, Dec. 25, 1915.

TYPHLOPS DENDROPHIS Taylor.

Holotype.

Type. Carnegie Museum, No. 2668. Originally EHT, No. 93.*Publ.* Bureau of Sci. Manila Publ. No. 16, Feb. 11, 1922, pp. 60-61.*Type loc.* Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Aug. 15, 1913.

TYPHLOPS LONGICAUDA Taylor.

Holotype.

Type. Carnegie Museum, No. 2761. Originally EHT, No. R 99.*Publ.* Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 108-109, pl. I, fig. 1.*Type loc.* Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, July 15, 1913.

TYPHLOPS LUZONENSIS Taylor.

Holotype.

Type. Originally EHT, No. 109.*Publ.* Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 105-106.*Type loc.* Mt. Maquiling, Laguna Prov., Luzon, P. I. *Coll.*, E. H. Taylor, May 12, 1915.**TYPHLOPS MANILAE** Taylor.

Holotype.

Type. Unnumbered specimen in Santo Tomás Museum, Manila, P. I.*Publ.* Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 106-108.*Type loc.* "Filipinas."**TYPHLOPS MINDANENSIS** Taylor.

Holotype.

Type. Carnegie Museum, No. 2667. Originally EHT, No. 96.*Publ.* Bureau of Sci. Manila Publ. No. 16, Feb. 11, 1922, pp. 65-66.*Type loc.* Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Aug. 12, 1913.**TYPHLOPS RUGOSA** Taylor.

Holotype.

Type. Carnegie Museum, No. 2665. Originally EHT, No. R 97.*Publ.* Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 109-110.*Type loc.* Bunawan, Agusan Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, July 14, 1913.**TYPHLOPS SULUENSIS** Taylor.

Holotype.

Type. Bureau of Science, No. 2001.*Publ.* Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 257-259, text fig. 11.*Type loc.* Bubuan, Tapan Group, Sulu Arch., P. I. *Coll.*, E. H. Taylor, Oct. 2, 1917.

TESTUDINATA

EMYS TWENTEI Taylor.

Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6478.*Publ.* Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 3, Oct. 15, 1943, pp. 249-254, pl. XX.*Type loc.* High terrace sands of Pleistocene Age on north side Cimarron river, 10 miles south of Meade, Meade county, Kansas (Loc. 7). *Coll.*, Dr. Claude W. Hibbard and party.**HEOSEMYS LEYTENSIS** Taylor.

Holotype.

Type. An unnumbered specimen in the Zoölogical Laboratory, Univ. of the Philippines (later acquired by the Bureau of Science). Number unknown.*Publ.* Philip. Journ. Sci., Vol. XVI, No. 2, Feb. 1920, pp. 131-133, pl. 1, figs. 3, 4; pl. 3, fig. 1.*Type loc.* Cabalian Leyte, P. I. *Coll.*, Gregorio Lopez, date unknown.

MAMMALIA

CYNOPTERUS ARCHIPELAGUS Taylor.

Holotype.

Type. EHT, No. M 345.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 182-184, fig. 8, map.*Type loc.* Polillo, Polillo, P. I. *Coll.*, E. H. Taylor, July, 1920.

CROCIDURA PALA WANENSIS Taylor.

Holotype.

Type. EHT, No. M 55.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 88-90, fig. 2, map.*Type loc.* Sir J. Brooke Point, Palawan, P. I. *Coll.*, E. H. Taylor, Sept. 29, 1923.

CROCIDURA PARVACAUDA Taylor.

Holotype.

Type. EHT, No. M 737.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 83-85, fig. 2, map.*Type loc.* Saub, Cotabato, Mindanao, P. I. *Coll.*, E. H. Taylor, April 27, 1923.

EMBALLONURA ALECTO PALAWANENSIS Taylor.

Holotype.

Type. EHT, No. M 72. *Paratypes.* EHT, Nos. M 68, 71.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 197-200, fig. 8, map.*Type loc.* Thumb peak, Palawan, P. I. *Coll.*, E. H. Taylor, Oct. 28, 1923.EONYCTERIS LONGICAUDA Taylor [= *Eonycteris robusta* Miller].

Holotype.

Type. EHT, No. M 561. *Paratypes.* EHT, Nos. 434-435, 438-439, 441, 446-447, 450, 561, 564.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 131-134, pl. 6, fig. 6-8, fig. 4, map.*Type loc.* Montalban caves, Montalban, Rizal Province, Luzon, P. I. *Colls.*, W. Schultze, Albert Herre, and E. H. Taylor.

HIPPOSIDEROS DIADEMA ANDERSENI Taylor.

Holotype.

Type. EHT, No. M 330.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 246-247, fig. 11, map.*Type loc.* Near Novaliches, Rizal Province, Luzon, P. I. *Coll.*, E. H. Taylor, March, 1922.

HIPPOSIDEROS WRIGHTI Taylor.

Holotype.

Type. EHT, No. M 381.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 237-239, fig. 11, map.*Type loc.* Deserted mine tunnel, Baguio, Benguet (near Headwaters Gold Mine). *Coll.*, E. H. Taylor and John Suarez Wright, July 26, 1923.

INSULAEMUS CALAMIANENSIS Taylor. Holotype. Genotype.*Type.* EHT, No. M 104.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 470-471, fig. 24, map.*Type loc.* Sea level, Minuit, Busuanga Island, Calamianes, P. I. *Coll.*, E. H. Taylor, April 18, 1918.**MACROGLOSSUS FRUCTIVORUS** Taylor. Holotype.*Type.* EHT, No. M 710.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 125-126, fig. 4, map.*Type loc.* Tatayan, Cotabato, Mindanao, P. I. *Coll.*, E. H. Taylor, March 5, 1923.**MEGAEROPS WETMOREI** Taylor. Holotype*Type.* EHT, No. M 770.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 191-193, fig. 8, map.*Type loc.* Near Tatayan, Cotabato, Mindanao, P. I. *Coll.*, E. H. Taylor, March, 1923.**MYOTIO BROWNI** Taylor. Holotype.*Type.* EHT, No. M 341.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 288-290, fig. 12, map.*Type loc.* Near Saub, Cotabato, Mindanao, P. I. *Coll.*, E. H. Taylor, April 15, 1923.**MYOTIS HERREI** Taylor. Holotype.*Type.* EHT, No. M 369.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 290-292, fig. 12, map.*Type loc.* Cave at Montalban, Rizal Province, Luzon, P. I. *Coll.*, W. Schultze, Albert W. Herre, and E. H. Taylor, Jan. 22, 1923.**MYOTIS JEANNEI** Taylor. Holotype.*Type.* EHT, No. M 340*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 284-286, fig. 12, map.*Type loc.* Near Caldera, Zamboanga, Mindanao, P. I. *Coll.*, E. H. Taylor, April, 1923.**MYOTIS PATRICIAE** Taylor. Holotype.*Type.* EHT, No. M 353.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 286-288, fig. 12, map.*Type loc.* Agusan Prov., Mindanao, P. I. *Coll.*, Collector and date unknown.

NANNOSCIURUS LUNCEFORDI Taylor.

Holotype.

Type. EHT, No. M 594.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 286-288, fig. 17, map.*Type loc.* Saub, Cotabato, Mindanao, P. I. *Coll.*, E. H. Taylor, April 29, 1923.PACHYURA PALAWANENSIS Taylor [= *Suncus palawanensis* (Taylor)]

Holotype.

Type. EHT, No. M 89. *Paratype.* EHT, No. M 90.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 78-80, fig. 2, map.*Type loc.* Taytay, Palawan, P. I. *Coll.*, unknown, May, 1913.

PHILIPPINOPTERUS LANEI Taylor.

Holotype.

Type. EHT, No. M 253. *Paratypes.* Nos. M 217-251; 253-307.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 314-320, fig. 15, map.*Type loc.* Saub, Cotabato, Mindanao, P. I. *Coll.*, E. H. Taylor, April 28, 1923.

PTEROPUS TABLASI Taylor.

Holotype.

Type. EHT, No. M 312.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 169-171, pl. 4, fig. 2, a-e; text fig. 6, map.*Type loc.* Near Odiongan, Tablas I., P. I. *Coll.*, E. H. Taylor, Jan., 1923.

RATTUS MINDANENSIS TABLASI Taylor.

Holotype.

Type. EHT, No. M 652. *Paratype.* EHT, No. M 651.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 439-440, fig. 21, map.*Type loc.* Odiongan, Tablas I., P. I. *Coll.*, E. H. Taylor, Jan. 18, 1923.

RATTUS PALAWANENSIS.

Holotype.

Type. EHT, No. M 32. *Paratypes.* EHT, Nos. M 27-31.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 416-419, fig. 20, map.*Type loc.* Sir J. Brooke Point, Palawan, P. I. *Coll.*, E. H. Taylor, Oct., 1923.

RHINOLOPHUS BUNKERI Taylor.

Holotype.

Type. EHT, No. M 367.*Publ.* Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 228-229, fig. 10, map.*Type loc.* Saub, Cotabato, Mindanao, P. I. *Coll.*, E. H. Taylor, April 26, 1923.

BIBLIOGRAPHY

(Papers of joint authorship are inserted in their proper chronological order)

- 1915 New species of Philippine lizards. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, March, 1915, pp. 89-109, pl. 1.

The following are described:

<i>Gymnodactylus agusanensis</i>	<i>Sphenomorphus mindanensis</i>
<i>Gymnodactylus annulatus</i>	<i>Sphenomorphus cori</i>
<i>Hemidactylus luzonensis</i>	<i>Sphenomorphus curtirostris</i>
<i>Ptychozoon intermedia</i>	<i>Sphenomorphus palustris</i>
<i>Luperosaurus compressicorpus</i>	<i>Dasia griffini</i>
<i>Lepidodactylus aureolineatus</i>	<i>Tropidophorus rivularis</i>
<i>Emoia ruficauda</i>	<i>Dibamus argenteus</i>

- 1917a *Brachymeles*, a genus of Philippine lizards. Philip. Journ. Sci. Vol. XII, No. 5, Sec. D, Sept., 1917, pp. 267-279, pl. 1; and text figs. 1-7.

Describes: *Brachymeles elerae*, and *Brachymeles burksi*.

- 1917b Snakes and Lizards known from Negros, with descriptions of new species and new subspecies. Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 353-381, pls. 1, 2; Text figs. 1, 2.

Describes the following new forms:

<i>Typhlops canlaonensis</i>	<i>Lepidodactylus christiani</i>
<i>Natrix dendrophiops</i>	<i>Sphenomorphus arboreus</i>
<i>negrosensis</i>	<i>Siaphos auriculatum</i>
<i>Pseudorhabdium mcnamarae</i>	<i>Leiolepisma [sic] pulchellum</i>
<i>Calamaria gervaisii</i> iridescens	<i>grande</i>
<i>Trimeresurus wagleri</i>	
<i>alboviridis</i>	

- 1918a Reptiles of Sulu Archipelago. Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 233-267, pls. 1-3; text figs. 1-11.

Describes:

<i>Luperosaurus joloensis</i>	<i>Brachymeles suluiensis</i>
<i>Hemiphyllodactylus insularis</i>	<i>Brachymeles vermis</i>
<i>Lepidodactylus divergens</i>	<i>Typhlops suluiensis</i>
<i>Sphenomorphus biparietalis</i>	

- 1918b Two new snakes of the genus *Holarchus* with descriptions of other Philippine species. Philip. Journ. Sci., Vol. XIII, No. 6, Sec. D, Nov., 1918, pp. 359-369, pls. 1, 2.

Describes: *Holarchus maculatus*, and *Holarchus burksi*.

- 1919a New or rare Philippine reptiles. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1919, pp. 105-125, pl. 1, 2; text figs. 1-4.

The following species are described:

<i>Typhlops luzonensis</i>	<i>Lepidodactylus naujanensis</i>
<i>Typhlops manilae</i>	<i>Gekko mindorensis</i>
<i>Typhlops longicauda</i>	<i>Siaphos kempi</i>
<i>Typhlops rugosa</i>	<i>Sphenomorphus lednickyn</i>
<i>Trimeresurus mcgregori</i>	<i>Sphenomorphus llanosii</i>

- 1919b Ipon fisheries of Abra River. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1919, pp. 127-130.

- 1920a Philippine turtles. Philip. Journ. Sci., Vol. 16, No. 2, Feb., 1920, pp. 111-144, pls. 1-7.

Heosemys leytensis described.

- 1920b Philippine Amphibia. Philip. Journ. Sci., Vol. 16, No. 3, March, 1920, pp. 213-359, pls. 1-10; text figs. 1-9. Errata pp. 649-650.

Describes:

<i>Rana moodiei</i>	<i>Hazelia spinosa</i>
<i>Rana parva</i>	<i>Philautus hazelae</i>
<i>Rana dubita</i>	<i>Philautus montanus</i>
<i>Rana guerreroi</i>	<i>Cornufer laticeps</i>
<i>Rana sanchezi</i>	<i>Chaperina beyeri</i>
<i>Rana suluensis</i>	<i>Chaperina visaya</i>
<i>Rana philippinensis</i>	<i>Nectophryne lighti</i>
<i>Rana grandocula</i>	<i>Megalophrys stejnegeri</i>
<i>Rana melanomenta</i>	<i>Megalophrys ligayae</i>
HAZELIA	<i>Ichthyophis weberi</i>

- 1921 Amphibians and turtles of the Philippine Islands. Department of Agriculture and Natural Resources, Bureau of Science, Manila, Publication. No. 15, Dec., 15, 1921, pp. 1-193, pls. 1-17; text figs. 1-9.

- 1922a The snakes of the Philippine Islands. Department of Agriculture and Natural Resources, Bureau of Science, Manila, Publication. No. 16, Feb. 11, 1922, pp. 1-312, pls. 1-37; text figs. 1-32.

The following species are described:

<i>Typhlops dendrophis</i>	<i>Dryophis griseus</i>
<i>Typhlops mindanensis</i>	<i>Dryophis piceocularis</i>
<i>Calamaria suluensis</i>	<i>Naja naja philippinensis</i>
<i>Calamaria tropica</i>	<i>Hemibungarus mcclungi</i>
<i>Boiga dendrophila divergens</i>	

- 1922b Additions to the herpetological fauna of the Philippine Islands, I. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 161-206, pls. 1-7.

Type descriptions of the following species are given:

<i>Rana merrilli</i>	<i>Bufo mcgregori</i>
<i>Cornufer cornutus</i>	<i>Gekko porosus</i>
<i>Philautus polillensis</i>	<i>Gekko smaragdinus</i>
<i>Philautus williamsi</i>	<i>Sphenomorphus bakeri</i>
<i>Philautus zamboangensis</i>	<i>Siaphos herrei</i>
<i>Philautus basilanensis</i>	<i>Dryocalamus mcclunyi</i>
<i>Kaloula negrosensis</i>	<i>Calamaria jolotensis</i>
<i>Kaloula kalingensis</i>	<i>Pseudorhabdium minutum</i>
<i>Kaloula rigida</i>	<i>Typhlogeophis ater</i>

- 1922c Additions to the herpetological fauna of the Philippine Islands, II. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 257-303, pls. 1-4.

The following type descriptions appear:

<i>Rana igorota</i>	<i>Cornufer subterrestris</i>
<i>Rana yakani</i>	<i>Polypedates linki</i>
<i>Rana tafti</i>	<i>Sphenomorphus beyeri</i>
<i>Micrixalus diminutiva</i>	<i>Tropidophorus stejnegeri</i>
<i>Cornufer rivularis</i>	<i>Natrix barbouri</i>
<i>Cornufer montanus</i>	

- 1922d The lizards of the Philippine Islands. Department of Agriculture and Natural Resources, Bureau of Science, Manila, Publ. No. 17, Dec. 7, 1922, pp. 1-269, pls. 1-23; text figs. 1-53.

The following described as new:

<i>Calotes marmoratus sanchezi</i>	<i>Sphenomorphus jagorii grandis</i>
<i>Sphenomorphus jagorii divergens</i>	<i>Brachymeles boulengeri</i>

- 1922e Herpetological fauna of Mount Makiling. The Philippine Agriculturist, Vol. XI, No. 5, Dec., 1922, pp. 127-139.

NOTE.—The last phrase in this article reads, "one lizard *Gonyocephalus bitorques* Peters." An entire line was dropped. This should read, "one lizard *Gonyocephalus* sp. (young) and one specimen of a small snake, *Calamaria bitorques* Peters.")

- 1923 Additions to the Herpetological fauna of the Philippine Islands, III. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 515-557, pls. 1-3.

The following type descriptions appear:

<i>Ichthyophis glandulosus</i>	<i>Sphenomorphus stejnegeri</i>
<i>Rana woodworthi</i>	<i>Cyclocorus nuchalis</i>
<i>Rana acanthi</i>	<i>Calamaria polillensis</i>
<i>Rana micrixalus</i>	<i>Calamaria hollandi</i>
<i>Lepidodactylus herrei</i>	<i>Boiga schultzei</i>
<i>Mabuya bontocensis</i>	

- 1924 [with Noble, G. Kingsley]. A new genus of discoglossid frogs from the Philippine Islands. Amer. Mus. Nov., No. 121, June 23, 1924, pp. 1-4, text fig. 1.

The genus BARBOURULA, and *Barbourula busuangensis* are described.

- 1925 Additions to the herpetological fauna of the Philippines, IV. Philip. Journ. Sci., Vol. 26, No. 1, Jan. 1925, pp. 97-111.

The following species are described:

<i>Mabuya engeli</i>	<i>Brachymeles pathfinderi</i>
INSULASAURUS	<i>Brachymeles wrighti</i>
<i>Insulasaurus wrighti</i>	<i>Holarchus perkinsi</i>

- 1928 Amphibians, lizards, and snakes of the Philippines. From, Distribution of Life in the Philippines. Dept. of Agriculture and Commerce, Bureau of Science, Manila, Monograph No. 21, 1928, pp. 214-242, pls. 27-32; text figs. 51-56.

- 1930a A revised checklist of the snakes of Kansas. Univ. Kansas Sci. Bull., Vol. XIX, No. 5, 1929 (1930), pp. 53-62.

- 1930b List of reptiles and batrachians of Morton County, Kansas, reporting species new to the state fauna. Univ. Kansas Sci. Bull., Vol. XIX, No. 6, 1929 (1930), pp. 63-65.

- 1930c A species of lizard new to the fauna of the United States: *Eumeces callicephalus* Bocourt. Univ. Kansas Sci. Bull., Vol. XIX, No. 7, 1929 (1930), pp. 67-69.

- 1931a Notes on two specimens of the rare snake *Ficimia cana*, and the description of a new species of *Ficimia* from Texas. Copeia, 1931, No. 1, March 31, pp. 4-7.

Ficimia streckeri is described.

- 1931b The discovery of a lizard *Sceloporus torquatus cyanogenys* Cope in Texas, new to the fauna of the United States. Proc. Biol. Soc. Washington, Vol. 44, Oct. 17, 1931, pp. 129-132.

- 1932a *Leptodactylus albilabris* (Günther): A species of toad new to the fauna of the United States. Univ. Kansas Sci. Bull., Vol. XX, No. 11, 1932 (Oct. 1), pp. 243-245.

- 1932b The toad *Bufo marinus* (Linnaeus) in Texas. Univ. Kansas Sci. Bull., [with Wright, John S.] Vol. XX, No. 12, 1932 (Oct. 1), pp. 247-249.

- 1932c *Eumeces inexpectatus*: A new American lizard of the family Scincidae. Univ. Kansas Sci. Bull., Vol XX, No. 13, 1932 (Oct. 1), pp. 251-259, pls. XVII-XVIII.

Eumeces inexpectatus described.

- 1932d *Eumeces laticeps*: A neglected species of skink. Univ. Kansas Sci. Bull., Vol. XX, No. 14, 1932 (Oct. 1), pp. 263-271, pls. XIX, XX.

- 1933a Two new Mexican skinks of the genus *Eumeces*. Proc. Biol. Soc. Washington, Vol. 46, June 30, 1933, pp. 129-138, 2 text figs.

Eumeces ochoterenae and *Eumeces copei* are described.

- 1933b Notes on type specimens of reptiles and amphibians in the "Alfredo Duges" Museum, Guanajuato, Mexico. Copeia, 1933, No. 2, July 20, p. 97.

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- 1934a Notes on Chinese reptiles and amphibians. Lingnan Science Journ. Canton, China, Vol. 13, No. 2, April 18, 1934, pp. 297-310.

Rana lighti described.

- 1934b Zoölogical results of the third De Schauensee Siamese Expedition, Part III. Amphibians and Reptiles. Proc. Acad. Nat. Sci. Philadelphia, Vol. LXXXVI, June 13, 1934, pp. 281-310, pl. 17; text figs. 1-4.

The following species are described:

Natrix deschauensei

Microhyla fowleri

Draco divergens

- 1934c Philippine land mammals. Bureau of Science Monograph. No. 30, June 30, 1934, pp. 1-548, pls. 1-25; text figs. 1-25.

The following mammals are described:

Pachyura palawanensis

Myotis jeannei

Crocidura parvacauda

Myotis patriciae

Crocidura palawanensis

Myotis browni

Macroglossus fructivorus

Myotis herrei

Pteropus tablasi

PHILIPPINOPTERUS

Cynopterus archipelagus

Philippinopterus lanei

Megacrops wetmorei

Nannosciurus luncefordi

Eonycteris longicauda

Rattus palawanensis

Emballonura alecto

Rattus mindanensis tablasi

palawanensis

INSULAE MUS

Rhinolophus bunkeri

Insulaemus calamianensis

Hipposideros wrighti

Hipposideros diadema

anderseni

- 1934d Notes on two collections of Hainan reptiles and amphibians. Lingnan Sci. Journ. (Canton, China), Vol. 13, No. 3, July 30, 1934, pp. 465-474.

- 1934e A new species of lizard from Mexico. Univ. Kansas Sci. Bull., Vol. XXI, No. 5, 1933 (Nov. 27, 1934), pp. 257-267, pls. XXIV, XXV.

Eumeces indubitatus is described.

- 1934f Observations on the courtship of turtles. Univ. Kansas Sci. Bull., Vol. XXI, No. 6, 1933 (Nov. 27, 1934), pp. 269-271.

- 1935a A new skink from Mexico. Zoöl. Ser. Field Mus. Nat. Hist., Vol. XX, No. 10, May 15, 1935, pp. 77-80, fig. 7.

- 1935b *Coleonyx fasciatus*, a neglected species of gecko. Univ. Kansas Sci. Bull., Vol. XXII, No. 9, 1935 (Nov. 15), pp. 203-205.
- 1935c Arkansas amphibians and reptiles in the Kansas University Museum, Univ. Kansas Sci. Bull., Vol. XXII, No. 10, 1935 (Nov. 15), pp. 207-218.
- 1935d A new species of the genus *Eumeces* from New Mexico. Univ. Kansas Sci. Bull., Vol. XXII, No. 11, 1925 (Nov. 15), pp. 219-223, fig. 1.
Eumeces gaipei described.
- 1936a Notes on a small herpetological collection from Western Australia. Tran. Kansas Acad. Sci., Vol. 38, 1935 (April 25, 1936), pp. 341-344.
- 1936b Proposed changes in the nomenclature of the scincoid lizard genus *Eumeces*. Trans. Kansas Acad. Sci., Vol. 38, 1935 (Apr. 25, 1936), pp. 345-347.
- 1936c Description of a new Sonoran snake of the genus *Ficimia*, with notes on other Mexican species. Proc. Biol. Soc. Washington, Vol. 49, May 1, 1936, pp. 51-54.
Type description of *Ficimia desertorum*.
- 1936d The rediscovery of the lizard *Eumeces altamirani* (Dugès) with notes on two other Mexican species of the genus. Proc. Biol. Soc. Washington, Vol. 49, May 1, 1936, pp. 55-58.
- 1936e A taxonomic study of the cosmopolitan scincoid lizards of the genus *Eumeces* with an account of the distribution and relationships of its species. Univ. Kansas Sci. Bull., Vol. XXIII, No. 1, 1935 (Aug. 15, 1936), pp. 1-643, pls. I-XLIII; figs. 1-84.
Eumeces gilberti rubricaudatus is described.
- 1936f Una nueva fauna de batracios anuros del Plioceno Medio, de Kansas. Anales Inst. Biol., (Mexico) Tomo VII, No. 4. 1936, pp. 513-529, Lam. 1, 2.
The following fossil forms are described:
Scaphiopus pliobatrachus *Bufo arenarius*
Bufo hibbardi
- 1936g Notes and comments on certain American and Mexican snakes of the genus *Tantilla*, with descriptions of new species. Trans. Kansas Acad. Sci. Vol. 39, 1936, pp. 335-348, text fig. 1-6.
Describes: *Tantilla hobartsmithi*, *Tantilla brevissima*, *Tantilla martinidelcampoi*.
- 1936h New species of amphibia from Mexico. Tran. Kansas Acad. Sci., Vol. 39, 1936 (—), pp. 349-363, pls. 1-2.
Type descriptions of *Leptodactylus occidentalis*, *Eleutherodactylus pygmaeus*, *Eleutherodactylus hobartsmithi*.
- 1937a Two new lizards of the genus *Leiopisma* from Mexico, with comments on another Mexican species. Copeia, 1937, No. 1, April 10, pp. 5-11.
Leiopisma silviculum and *Leiopisma forbesorum* are described.
- 1937b New species of hylid frogs from Mexico with comments on the rare *Hyla bistincta* Cope. Proc. Biol. Soc. Washington, Vol. 50, April 21, 1937, pp. 43-54, pls. II, III.
Hyla robertmertensi, *Hyla pinorum* and *Hyla erythromma* are described.
- 1937c A new snake of the genus *Sonora* from Mexico, with comments on *S. michoacanensis*. Herpetologica, Vol. 1, July 15, 1937, pp. 69-72, pls. VI, VII.
Type description of *Sonora erythrura*.

- 1938a Notes on the herpetological fauna of the Mexican state of Sonora. Univ. Kansas Sci. Bull., Vol. XXIV, No. 19, 1936 (Feb. 15, 1938), pp. 475-503, pl. XLIII.

Cnemidophorus burti described.

- 1938b Notes on the herpetological fauna of the Mexican state of Sinaloa. Univ. Kansas Sci. Bull., Vol. XXIV, No. 20, 1936 (Feb. 15, 1938), pp. 505-537, pls. XLIV-XLVI.

Type description of *Bufo kelloggi* and *Trimorphodon paucimaculata*.

- 1938c Does the amphibiaenid genus *Bipes* occur in the Stated States? Copeia, 1938, No. 4, December 10, p. 202.

- 1939a On North American snakes of the genus *Leptotyphlops*. Copeia, 1939, No. 1, March 9, pp. 1-7, pl. 1.

Leptotyphlops bressoni is described.

- 1939b Two new species of the genus *Anomalepis* Jan, with a proposal of a new family of snakes. Proc. New England Zool. Club., Vol. XVII, June 26, 1939, pp. 87-96, pl. V.

Family *ANOMALEPIDAE* and *Anomalepis dentatus*, *Anomalepis aspinosus* are described.

- 1939c [with Smith, Hobart M.] Miscellaneous notes on Mexican snakes. Univ. Kansas Sci. Bull., Vol. XXV, No. 13, 1938 (July 10, 1939), pp. 239-258, pl. XXIII; text figs. 1-4.

Geophis blanchardi is described.

- 1939d Concerning Mexican Salamanders. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 259-313, pls. XXIV-XXX.

The following species are described as new:

<i>Ambystoma schmidtii</i>	<i>Oedipus smithi</i>
<i>Oedipus robertsi</i>	<i>Oedipus giganteus</i>
<i>Oedipus altamontanus</i>	<i>Oedipus manni</i>
<i>Oedipus multidentata</i>	

- 1939e Notes on the Mexican snakes of the genus *Leptodeira* with a proposal of a new snake genus, *Pseudoleptodeira*. Univ. Kansas Sci. Bull., Vol. XXV, No. 15, 1938 (July 10, 1939), pp. 315-355, pls. XXX-XXXIV; text figs. 1-7.

Pseudoleptodeira nov. gen. described, also *Leptodeira bressoni*, and *Leptodeira smithi*.

- 1939f On the Mexican snakes of the Genera *Trimorphodon* and *Hypsiglena*. Univ. Kansas Sci. Bull., Vol. XXV, No. 16, 1938 (July 10, 1939), pp. 357-383, pls. XXXV-XXXVIII; text fig. 1.

Hypsiglena torquata dunklei is described.

- 1939g New species of Mexican tailless amphibia. Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 385-405, pls. XXXIX-XLI; text figs. 1-2.

Type descriptions of the following:

<i>Hyla arborescens</i>	<i>Eleutherodactylus cactorum</i>
<i>Hyla rickardsi</i>	<i>Rana sierramadrensis</i>
<i>Eleutherodactylus natator</i>	

- 1939h A new anuran amphibian from the Pliocene of Kansas. Univ. Kansas Sci. Bull., Vol. XXV, No. 18, 1938 (July 10, 1939), pp. 407-419, pls. XLII-XLV.

Type description of *Scaphiopus studei*.

- 1939i Frogs of the *Hyla eximia* group in Mexico, with descriptions of two new species. Univ. Kansas Sci. Bull., Vol. XXV, No. 19, 1938 (July 10, 1939), pp. 421-445, pls. XLVI-XLVIII.

Hyla cardenasi and *Hyla wrightorum* are described.

- 1939j A new bromeliad frog. Copeia, 1939, No. 2, July 12, pp. 97-100, fig. 1.

Hyla bromeliana described.

- 1939k A new species of the lizard genus *Lepidophyma* from Mexico. Copeia, 1939, No. 3, Sept. 9, pp. 131-133, figs. 1-2.

Lepidophyma sylvatica is described.

- 1940a A new eleutherodactylid frog from Mexico. Proc. New England Zool. Club, Vol. XVIII, Jan. 24, 1940, pp. 13-16, pl. I, II.

Eleutherodactylus batrachylus is described.

- 1940b A new *Rhyacosiredon* (Caudata) from western Mexico. Herpetologica, Vol. 1, No. 7, Jan. 29, 1940, pp. 171-176, pl. XVII.

Rhyacosiredon rivularis is described.

- 1940c Two new snakes of the genus *Thamnophis* from Mexico. Herpetologica, Vol. 1, No. 7, Jan. 29, 1940, pp. 183-189, pl. XIX; text figs. 1-2.

Thamnophis halophilus and *Thamnophis ebурatus* are described.

- 1940d A new bromeliad frog from northwestern Michouacan. Copeia, 1940, No. 1, March 30, pp. 18-20, fig. 1.

Hyla smaragdina is described.

- 1940e Two new anuran amphibians from Mexico. Proc. U. S. Nat. Mus., Vol. 89, No. 3093, 1940, pp. 43-47, pls. 1-3.

Syrhrophus smithi and *Hyla dendroscarta* are described.

- 1940f A new *Syrhrophus* from Guerrero, Mexico. Proc. Biol. Soc. Washington, Vol. 53, Oct. 7, 1940, pp. 95-98, pl. 1.

Syrhrophus pipilans is described.

- 1940g Palatal sesamoid bones and palatal teeth in *Cnemidophorus*, with notes on these teeth in other saurian genera. Proc. Biol. Soc. Washington, Vol. 53, Oct. 7, 1940, pp. 119-124, pl. II.

- 1940h [with Knobloch, Irving W.] Report on an herpetological collection from the Sierra Madre Mountains of Chihuahua. Proc. Biol. Soc. Washington, Vol. 53, Oct. 7, 1940, pp. 125-130.

- 1940i New species of Mexican Anura. Univ. Kansas Sci. Bull., Vol. XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 385-405, pls. XLIII and XLIV; text figs. 1-8.

Describes:

Hyla hazelae

Hyla robustofemora

Hyla robertsoni

Syrhrophus latodactylus

Eleutherodactylus vocalis

- 1940j New salamanders from Mexico, with a discussion of certain known forms. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 407-439, pls. XLV-XLVIII; text figs. 1-5.

The following species are described:

Bolitoglossa dimidiata

Thorius pulmonaris

Thorius narisovalis

Ambystoma bombypella

Ambystoma ordinaria

Ambystoma amblycephala

Siredon lermaensis

1940k Mexican snakes of the genus *Typhlops*. Univ. Kansas Sci. Bull., Vol. XXVI, No. 13, 1939 (Nov. 27, 1940), pp. 441-444, figs. 1, 2.

1940l Some Mexican serpents. Univ. Kansas Sci. Bull., Vol. XXVI, No. 14, 1939 (Nov. 27, 1940), pp. 445-487, pl. XLIX-LII; text figs. 1-9.

Tropidodipsas guerreroensis is described.

1940m Herpetological miscellany No. I. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 489-571, pls. LIII-LXIII; text figs. 1-7.

The following species are described as new:

<i>Bufo gemmifer</i>	<i>Hypopachus otis</i>
<i>Bufo mazatlanensis</i>	<i>Hypopachus maculatus</i>
<i>Tomodactylus angustidigitorum</i>	<i>Hypopachus caprimimus</i>
<i>Tomodactylus macrotymp-panum</i>	<i>Hypopachus alboventer</i>
	<i>Hypopachus cuneus</i>
	<i>nigroreticulata</i>
MICROBATRACHYLUS	<i>Leptotyphlops magnamaculata</i>
<i>Microbatrachylus albolabris</i>	<i>Leptotyphlops rufidorsum</i>
<i>Microbatrachylus onzaca</i>	<i>Leptotyphlops nasalis</i>
<i>Microbatrachylus minimus</i>	<i>Leptotyphlops ater</i>
<i>Hyla melanomma</i>	<i>Phyllodactylus muralis</i>
<i>Hyla forbesi</i>	<i>Phyllodactylus magnatuberculata</i>

1940n A new frog from the Tarahumara Mountains of Mexico. Copeia, 1940, No. 4, Dec. 27, pp. 250-253, fig. 1.

Eleutherodactylus tarahumaraensis described.

1940o A new *Lampropeltis* from western Mexico. Copeia, 1940, No. 4, Dec. 27, pp. 253-255, text figs. 1-2.

Lampropeltis knoblochi described.

1941a New plethodont salamanders from Mexico. Herpetologica, Vol. 2, No. 3, March 25, 1941, pp. 57-65, text figs. 1-5.

Describes: *Bolitoglossa unguidentis* and *Bolitoglossa arborea*.

1941b Extinct lizards from Upper Pliocene deposits of Kansas. Univ. Kansas Publ., State Geol. Surv. Kansas, Bull. No. 38, 1941 Reports of Studies, part 5, July 7, 1941, pp. 165-176, figs. 1-6.

Describes:

<i>Eumeces striatulus</i>	<i>Eumecoides mylocoelus</i>
EUMECOIDES	<i>Cnemidophorus bilobatus</i>
<i>Eumecoides hibbardi</i>	

1941c Extinct toads and salamanders from Middle Pliocene beds of Wallace and Sherman counties, Kansas. Univ. Kansas Publ., State Geol. Surv. Kansas, Bull. No. 38, 1941. Reports of Studies, part 6, July 7, 1941, pp. 177-196, figs. 1-7.

Describes the following:

<i>Scaphiopus antiquus</i>	OGALLALABATRACHUS
LANEBATRACHUS	<i>Ogallalabatrachus horarium</i>
<i>Lanebatrachus martini</i>	

1941d A new plethodont salamander from New Mexico. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 77-80.

Describes: *Plethodon hardii*.

1941e Two new species of Mexican plethodontid salamanders. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 81-86.

Describes: *Bolitoglossa melanomolge* and *Bolitoglossa galeanae*.

- 1941f Some Mexican frogs. *Proc. Biol. Soc. Washington*, Vol. 54, July 31, 1941, pp. 87-94.

Type descriptions of the following:

<i>Microbatrachylus lineatissimus</i>	<i>Eleutherodactylus occidentalis</i> (nov. nom.)
<i>Eleutherodactylus saltator</i>	

- 1941g Smith, Hobart M. with Taylor, Edward H. A review of the snakes of the genus *Ficimia*. *Journ. Washington Acad. Sci.* Vol. 31, No. 8, Aug. 15, 1941, pp. 356-368, 1 plate, (fig.), figs. 1-16, Map fig. 17.

Ficimia ruspator is described.

- 1941h Two new ambystomid salamanders from Chihuahua. *Copeia*, 1941, No. 3, Sept. 30, pp. 143-146, figs. 1-2.

Ambystoma rosaceum and *Ambystoma fluvinatum* are described.

- 1941i A new Anuran from the Middle Miocene of Nevada. *Univ. Kansas Sci. Bull.*, Vol. XXVII, pt. 1, No. 4, 1941 (Dec.) pp. 61-69, pl. I; text fig. 1.

Describes the genus *Miopelodytes* and *Miopelodytes gilmorei*.

- 1941j Herpetological miscellany No. II. *Univ. Kansas Sci. Bull.*, Vol. XXVII, pt. 1, No. 7, 1941 (Dec.), pp. 105-139, pls. III-VI; text figs. 1-7.

The following are described:

<i>Thorius dubitus</i>	<i>Hyla arboricola</i>
<i>Thorius troglodytes</i>	<i>Grophis maculifera</i>
<i>Bolitoglossa chondrostega</i>	<i>Oryzichthys potosiensis</i>
<i>Bolitoglossa terrestris</i>	<i>Crotalus triseriatus gloydi</i>

- 1941k New amphibians from the Hobart M. Smith Mexican collections. *Univ. Kansas Sci. Bull.*, Vol. XXVII, pt. 1, No. 8, 1941 (Dec.), pp. 141-167, pl. VII-XI; text figs. 1, A-C.

Describes the following new forms:

<i>Bolitoglossa nigromaculata</i>	<i>Bolitoglossa nigroflavescens</i>
<i>Bolitoglossa occidentalis</i>	<i>Eleutherodactylus matudae</i>
<i>Bolitoglossa xolocae</i>	<i>Eleutherodactylus dorsoconcolor</i>

- 1942a Tadpoles of Mexican anura. *Univ. Kansas Sci. Bull.*, Vol. XXVIII, pt. 1, No. 3, May 15, 1942, pp. 37-55, pls. I-III.

- 1942b The frog genus *Diaglena*, with a description of a new species. *Univ. Kansas Sci. Bull.*, Vol. XXVIII, pt. 1, No. 4, May 15, 1942, pp. 57-65, pls. IV, V.

Describes: *Diaglena reticulata*.

- 1942c New tailless amphibia from Mexico. *Univ. Kansas Sci. Bull.*, Vol. XXVIII, pt. 1, No. 5, May 15, 1942, pp. 67-89, pls. VI-IX.

The following species are described:

<i>Microbatrachylus montanus</i>	<i>Centrolenella viridissima</i>
<i>Microbatrachylus imitator</i>	<i>Hyla rozellae</i>
<i>Eleutherodactylus macdougalli</i>	

- 1942d Some geckoes of the genus *Phyllodactylus*. *Univ. Kansas Sci. Bull.*, Vol. XXVIII, pt. 1, No. 6, May 15, 1942, pp. 91-112, text figs. 1-6.

Describes:

<i>Phyllodactylus magnus</i>	<i>Phyllodactylus darwini</i>
<i>Phyllodactylus bordai</i>	

- 1942e Mexican snakes of the genera *Adelophis* and *Storeria*. *Herpetologica*, Vol. 2, No. 4, July 15, 1942, pp. 75-79.

Describes: *Storeria hidalgoensis*.

- 1942f "Island" Faunas on the Mexican plateau. *Proc. Eighth American Scientific Congress*, Vol. 3, Aug., 1942, pp. 503-504.

- 1942g. Extinct toads and frogs from the Upper Pliocene deposits of Meade County, Kansas. *Univ. Kansas Sci. Bull.*, Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 199-235; pls. XIV-XX.

Describes:

Scaphiopus diversus

NEOSCAPHIOPUS

Neoscaphiopus noblei

ANCHYLORANA

Anchylorana moorei

Anchylorana dubita

Anchylorana robustocondyla

Rana fayneae

Rana meadensis

Rana ephippium

Rana rerroadensis

Rana valida

Rana parvissima

- 1942h [with Smith, Hobart M.] Concerning the snake genus *Pseudoficimia*. *Univ. Kansas Sci. Bull.*, Vol. XXVIII, pt. II., No. 12, Nov. 15, 1942, pp. 241-251, pl. XXI; text figs. 1-4.

Pseudoficimia pulcherrima described.

- 1942i New Caudata and Salientia from Mexico. *Univ. Kansas Sci. Bull.*, Vol. XXVIII, pt. II., No. 14, Nov. 15, 1942, pp. 295-323 pls. XXV-XXIX.

The following species are described:

Eleutherodactylus bolivari

Eleutherodactylus decoratus

Eleutherodactylus hidalgoensis

Syrrophus modestus

Hyla beltrani

Hyla pachyderma

Rana megapoda

Bolitoglossa lavae

- 1942j [with Smith, Hobart M.] The snake genera, *Conopsis* and *Toluca*. *Univ. Kansas Sci. Bull.*, Vol. XXVIII, pt. II, No. 15, Nov. 15, 1942, pp. 325-363; pls. XXX-XXV; text figs. 1-2.

Describes the following forms:

Conopsis biserialis

Toluca megalodon

Toluca conica

- 1943a [with Hesse, C. J.] A new salamander from the upper Miocene beds of San Jacinto County, Texas. *Amer. Journ. Sci.*, Vol. 241, March 1943, pp. 185-193, fig. 1.

Describes: *Batrachosauroides* and *Batrachosauroides dissimulans*.

- 1943b A new *Hylella* from Mexico. *Proc. Biol. Soc. Washington*, Vol. 56, June 16, 1943, pp. 49-52.

Describes: *Hylella azteca*.

- 1943c A new ambystomid salamander adapted to brackish water. *Copeia*, 1943, No. 3, Oct. 15, pp. 151-156, text figs. 1-3.

Describes: *Ambystoma subsalsum*.

- 1943d An extinct turtle of the genus *Emys* from the Pleistocene of Kansas. *Univ. Kansas Sci. Bull.*, Vol. XXIX, pt. II, No. 3, Oct. 15, 1943, pp. 249-254, pl. XX.

Describes: *Emys twentiei*.

- 1943e The Mexican lizards of the genus *Eumeces* with comments on the recent literature of the genus. *Univ. Kansas Sci. Bull.*, Vol. XXIX, pt. II, No. 5, Oct. 15, 1943, pp. 269-300.

- 1943f [with Smith, Hobart M.] A review of the American Sibynophine Snakes with a proposal of a new genus. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 6, Oct. 15, 1943, pp. 301-338, pls. XXI-XXV; text figs. 1-9.

Describes:

<i>Scaphiodontophis</i>	<i>Scaphiodontophus cyclurus</i>
<i>Scaphiodontophis</i>	<i>Scaphiodontophis nothus</i>
<i>albonuchalis</i>	<i>Scaphiodontophis carpicinctus</i>

- 1943g Skin shedding in the salamander *Amphiuma means*. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 7, 1943, pp. 339-341.

- 1943h Herpetological novelties from Mexico. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 343-361, pls. XXVI-XXVII.

Describes:

<i>Rhynchosiredon leonae</i>	<i>Syrhophus nebulosus</i>
<i>Bolitoglossa cochranae</i>	<i>Tomodactylus albolabris</i>
<i>Bufo nayaritensis</i>	<i>Microhyla mazatlanensis</i>
<i>Bufo perplexus</i>	

- 1944a A new genus and species of Mexican frogs. Univ. Kansas Sci. Bull., Vol. XXX, pt. I, No. 3.

Describes: *Ptychohyla*, and the genotype *Ptychohyla adipoventris*.

- 1944b Two new species of crotalid snakes from Mexico. Univ. Kansas Sci. Bull., Vol. XXX, No. 4.

Describes: *Crotalus semicornutus* and *Crotalus transversus*.

- 1944c A new ambystomid salamander from the plateau region of Mexico. Univ. Kansas Sci. Bull., Vol. XXX, pt. 1, No. 5.

Describes: *Ambystoma granulolum*.

- 1944d The hylid genus *Acrodytes*, with comments on Mexican forms. Univ. Kansas Sci. Bull., Vol. XXX, pt. 1, No. 6.

Describes: *Acrodytes inflata*.

- 1944e Present location of certain herpetological and other types. Univ. Kansas Sci. Bull., Vol. XXX, No. 1, pp. 117-187.

- 1944f The genera of Mexican plethodontid salamanders. Univ. Kansas Sci. Bull., Vol. XXX, No. 1, pp. 189-232.

- 1944g [Hobart M. Smith] and ————. Check list and key to the snakes of Mexico. In press.

- 1944h ———— with Hobart M. Smith. Summary of the Collections of Amphibians made in Mexico under the Walter Rathbone Bacon Scholarship. In press.

Describes:

<i>Ambystoma lacustris</i>	<i>Syrhophus rubrimaculata</i>
<i>Rhynchosiredon zemponlaensis</i>	<i>Eleutherodactylus avocalis</i>
<i>Pseudoeurycea cephalica</i>	<i>Eleutherodactylus conspicuus</i>
<i>rubrimembris</i>	<i>Acrodytes modesta</i>
<i>Bufo angustipes</i>	

- 1944i Hobart M. Smith with ————. Checklist and key to the Amphibians of Mexico. In press.

FIRST SUPPLEMENT

List of Type Specimens in the EHT-HMS Collection

(Described by various authors)

AMPHIBIA

CAUDATA

OEDIPUS BROMELIACIA Schmidt.

Paratype.

Paratypes. EHT-HMS, Nos. 27289-27290, topotypes. [Exc. Field Mus.]*Publ.* Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 159-161, fig. 18.*Type loc.* Volcan Tajumulco, 8,000 ft. above El Porvenir, San Marcos, Guatemala.

OEDIPUS DUNNI Schmidt.

Paratype.

Paratypes. EHT-HMS, Nos. 27278-27279, topotypes. [Exc. Field Mus.]*Publ.* Zoöl. Ser. Field Mus. Nat. Hist., 20, 1933, pp. 16-17.*Type loc.* Mts. W. San Pedro, Honduras.

OEDIPUS ENGLEHARDTI Schmidt.

Paratype.

Paratypes. EHT-HMS, Nos. 27275-27277, topotypes [Exc. Field Mus.]*Publ.* Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 156-157, fig. 18.*Type loc.* Volcan Atitlan, 7,000 ft. above Olas de Moca, Solola, Guatemala.

OEDIPUS FLAVIMEMBRIS Schmidt.

Paratype.

Paratype. EHT-HMS, No. 27272, topotype. [Exc. Field Mus.]*Publ.* Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 158-159, fig. 17.*Type loc.* Volcan Tajumulco, 7,200, on trail above El Porvenir, San Marcos, Guatemala.

OEDIPUS FRANKLINI Schmidt.

Paratype.

Paratypes. EHT-HMS, Nos. 27273-27274, Volcan Atitlan, 7,000 ft., Guatemala (above Olas de Moca). [Ex. Field Mus.]*Publ.* Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 159-161, fig. 19.*Type loc.* Volcan Tajumulco, 5,600 ft. elev. on trail above El Porvenir, San Marcos, Guatemala.

OEDIPUS GOEBELI Schmidt.

Paratype.

Paratypes. EHT-HMS, Nos. 29878-29879, topotypes. [Exc. Field Mus.]*Publ.* Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 163-164, fig. 17.*Type loc.* Volcan Tajumulco, 8,000 ft., on trail above El Porvenir, San Marcos, Guatemala.

OEDIPUS HELMRICHI Schmidt.

Paratype.

Paratype. EHT-HMS, No. 27073, topotype. [Exc. Field Mus.]*Publ.* Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 152-154, fig. 18.*Type loc.* Mountains above Finca Samac, west of Coban, Alta Verapaz, Guatemala, 5,000 ft.

OEDIPUS NASALIS Dunn.

Paratype.

Paratypes. EHT-HMS, Nos. 27286-27287. [Exc. Field Mus.]*Publ.* Zoöl. Ser. Field Mus. Nat. Hist., 12, 1924, p. 97.*Type loc.* Mountains above San Pedro, Honduras.**OEDIPUS TOWNSENDI** Dunn.

Paratype.

Paratype. EHT-HMS, No. 28562, topotype. [Exc. M. C. Z. Harvard Coll.]*Publ.* Proc. Biol. Soc. Washington, 35, 1922, p. 5.*Type loc.* Cerro de los Estropajos, near Jalapa, Veracruz.

SALIENTIA

ATELOPUS SPURRELLI CERTUS Barbour.

Paratype.

Paratypes. EHT-HMS, Nos. 29859, 29859A, topotypes Exc. M. C. Z. Harvard College.*Publ.* Occ. Papers Mus Zoöl Univ. Michigan No. 129, 1923, pp. 15-21.*Type loc.* Mt. Sapo, eastern Panamá Republic.**CHAPERINA PUNCTATA** van Kampen

Cotype.

Cotype. EHT-HMS, No 29862, Heuvelbivak, 800 m. "Went-gebirge" south New Guinea. [Exc Zoöl Mus Amsterdam]*Publ.* Nova Guinea. Résultats de l'expédition Scientifique néerlandaise à la Nouvelle-Guinée, Vol IX, Zoologie, Liv. 3, 1913, pp. 463-464, pl XI, fig. 7.*Type loc.* Went Mts and Helwig Mts, south New Guinea.**CORNUFER BEAUFORTI** van Kampen = (?) **RANA BEAUFORTI** (van Kampen)

Cotype.

Cotype. EHT-HMS No 29864, Waigeu. [Exc. Zoöl. Mus. Amsterdam.]*Publ.* Bijdr. t. d. Dierk, pt 19, 1913, p 91.*Type loc.* Waigeu I, East Indian Archipelago.**DENDROBATES MINUTUS VENTRIMACULATUS** Shreve. Paratype.*Paratype.* EHT-HMS, No. 29860, Pastaza river, Conellos to Marañon, Ecuador. [Exc. M. C. Z. Harvard Coll.]*Publ.* Occ. Papers Boston Soc. Nat. Hist., 8, July 30, 1935, pp. 209-218.*Type loc.* Sarayacu, Ecuador.**ELEUTHERODACTYLUS PARVUS** Barbour and Shreve.

Paratype.

Paratype. EHT-HMS, No. 29858, topotype. [Exc. M. C. Z. Harvard Coll.]*Publ.* Bull. Mus. Comp. Zoöl. Harvard Coll., 80, No. 9, 1937, pp. 386-387, pl. 2, figs. 3-4.*Type loc.* Cueva del Aura, Turquino peak, circa 3,500 ft., Oriente, Cuba.**ELEUTHERODACTYLUS TALAMANCAE** Dunn.

Paratype.

Paratypes. EHT-HMS, Nos. 29873-29874, La Loma, Panamá. [Exc. M. C. Z. Harvard Coll.]*Publ.* Occ. Papers Boston Soc. Nat. Hist., 5, 1931, p. 385.*Type loc.* Almirante, Panamá.**ELEUTHERODACTYLUS TURQUINENSIS** Barbour and Shreve.

Paratype.

Paratype. EHT-HMS, No. 29880, topotype. [Exc. M. C. Z. Harvard Coll.]*Publ.* Bull. Mus. Comp. Zoöl. Harvard Coll., 80, No. 9, Sept., 1937, pp. 380-382, pl. 3, fig. 1.*Type loc.* Cueva del Aura, Turquino Peak, Oriente, Cuba.

ELEUTHERODACTYLUS SPATULATUS Smith.

Paratype.

Paratypes. EHT-HMS, Nos. 18826 (S. 4474), 18830 (S. 4478).*Publ.* Proc. Biol. Soc. Washington, 52, Dec. 15, 1939, pp. 187-190, pl. II, figs. 1-5*Type loc.* Cuautlapan, Veracruz, México. *Coll.*, H. M. Smith, Jan. 5, 1939.**GASTROTHERCA BOLIVIANA GRISWOLDI** Shreve.

Paratype.

Paratypes. EHT-HMS, Nos. 29871-29872, topotypes. [Exc. M. C. Z. Harvard Coll.]*Publ.* Proc. New England Zool. Club, 18, Sept. 13, 1941, pp. 71-83.*Type loc.* Maraynioc, 72 km. N.E. Tarma (12,000 ft.), Dept. Junin, Perú.**HYLA LOQUAX** Gaige.

Paratype.

Paratype. EHT-HMS, No. 29842, topotype [Exc. Mus. Zool. Univ. Michigan.]*Publ.* Occ. Papers Mus. Zool., Univ. Michigan, No. 281, June 9, 1934, pp. 1-3.*Type loc.* Ixpuc Aguada, north of La Libertad, El Petén, Guatemala.**HYLA PARKERI** Gaige.

Paratype.

Paratypes. EHT-HMS, Nos. 29867-29868, topotypes. [Exc. Michigan Mus. Zool.]*Publ.* Occ. Papers Mus. Zool., Univ. Michigan, No. 207, Sept. 28, 1929, pp. 1-3.*Type loc.* Buenavista, Dept. Santa Cruz, Bolivia, S. A.**HYLA SANGUINOLENTA** van Kampen.

Cotype.

Cotype. EHT-HMS, No. 29866, Lorentz River (Noord-fluss), south New Guinea. [Exc. Zool. Mus. Amsterdam.]*Publ.* Nova Guinea Résultats de l'Expédition Scientifique néerlandaise à la Nouvelle-Guinée, Vol. IX, Zoologie, 1909, pp. 33-34, pl. II, fig. 3.*Type loc.* "Noord-Fluss bei Bivac Insel; Noord-Fluss; Noord-Fluss bei Sabang," south New Guinea *Coll.*, Lorentz Expedition, 1907.**HYLOXALUS PANAMANSIS** (sic) Dunn.

Paratype.

Paratype. EHT-HMS, No. 29729, topotype [Exc. M. C. Z. Harvard Coll.]*Publ.* Occ. Papers Boston Soc. Nat. Hist., 8, June 7, 1933, pp. 69-71.*Type loc.* El Valle de Anton, Province of Panamá.**PELOPHRYNE ALBOTAENIATA** Barbour.

Paratype.

[Paratype.] EHT-HMS, No. 29845, Thumb Peak, Palawan, P. I. Topotype [not designated as paratype but collected at same spot, the same day (Oct. 17, 1923)].

Publ. Proc. Biol. Soc. Washington, 51, Nov. 3, 1938, pp. 194-195, fig.*Type loc.* Elevation, 4,500 ft., Thumb Peak, Palawan, P. I.**PHANEROTIS NOVAE-GUINEA** van Kampen.

Cotype.

Cotype. EHT-HMS, No. 29861, Merauke, south New Guinea. [Exc. Zool. Mus. Amsterdam.]*Publ.* Nova Guinea. Résultats de l'expédition Scientifique néerlandaise à la Nouvelle-Guinée, Vol. IX, 1919, p. 36, pl. 2, fig. 4.*Type loc.* Merauke, south New Guinea.

PHYLLOBATES FLOTATOR Dunn.

Paratype.

Paratypes. EHT-HMS, Nos. 29726, 29727, 29736, topotypes. [Exc. M. C. Z. Harvard Coll.]

Publ. Occ. Papers Boston Soc. Nat. Hist., 5, 1931, p. 389.

Type loc. Barro Colorado I, Canal Zone.

RANA KOHCHANGAE M. Smith.

Cotype.

Cotype. EHT-HMS, No. 29884, topotype. [Exc. Malcolm Smith.]

Publ. Journ. Nat. Hist. Siam, IV, No. 4, July 25, 1922, pp. 223-225.

Type loc. Koh Chang I. (Chang I.), Inner Gulf of Siam.

RANA MICROTYPANUM van Kampen.

Cotype.

Cotype. EHT-HMS, No. 29865, Loka, near Bonthain, Celebes (one of 6 cotypes). [Exc. Zoöl. Mus. Amsterdam.]

Publ. Zoöl. Ergebnisse einer reise in Niederländisch Ost-Indien herausgegeben von Dr. Max Weber, Bd. IV, Heft. 2, 1907, pp. 386-388, pl. XVI, fig. 2.

Type loc. Loka bei Bonthain, Celebes. *Coll.*, M. Weber.

RANA MILLETTI M. Smith.

Cotype.

Cotype. EHT-HMS, No. 29886, Langbian, South Annam. [Exc. Malcolm Smith.]

Publ. Proc. Zoöl. Soc. London, 1921 (June), pp. 432-433, pl. II, fig. 2.

Type loc. Dalat, South Annam.

RANA MONTIVAGA M. Smith.

Cotype.

Cotype. EHT-HMS, No. 29885, Langbian Plateau, south Annam. [Exc. Malcolm Smith.]

Publ. Proc. Zoöl. Soc. London, 1921 (June), pp. 436-437, pl. I, fig. 2.

Type loc. Dalat, Langbian Plateau, south Annam.

SYRRHOPUS (sic) **CARYOPHYLLACEUS** Barbour [= *Eleutherodactylus caryophyllaceus* (Barbour)].

Paratype.

Paratypes. EHT-HMS, Nos. 29869-29870, topotypes. [Exc. M. C. Z., Harvard Coll.]

Publ. Proc. New England Zoöl. Club, 10, Mar. 2, 1928, p. 28, pl. 2, fig. 1.

Type loc. La Loma, W. Panamá.

SYRRHOPUS (sic) **JUNINENSIS** Shreve.

Paratype.

Paratype. EHT-HMS, No. 29866, topotype. [Exc. M. C. Z., Harvard Coll.]

Publ. Journ. Washington Acad. Sci., 28, No. 9, Sept. 15, 1938, pp. 406-407.

Type loc. Cascas, near Huasahuasi, Dept. Junin, Perú.

XENORHINA OCELLATA van Kampen.

Cotype.

Cotype. EHT-HMS, No. 29863, Hellwig Mts., south New Guinea. (one of three cotypes). [Exc. Zoöl. Mus. Amsterdam.]

Publ. Nova Guinea. Résultats de l'Expédition scientifique néerlandaise à la Nouvelle-Guinée, Vol. IX, Zoologie, Liv. 3, 1913, p. 461, pl. XI, figs. 4, 5.

Type loc. Hellwig Mts., about 2,500 m., south New Guinea. *Coll.*, van Kampen.

REPTILIA

LACERTILIA

ANOLIS DUNNI Smith.

Holotype.

Type. EHT-HMS, No. 11129. Orig. EHT-HMS Field No. 1506.*Publ.* Copeia, 1936, No. 1 (May 10), p. 9.*Type loc.* Between Rincón and Cajones [near Agua del Obispo], Guerrero, México. *Coll.*, E. H. Taylor, July 1, 1932.

ANOLIS MEGAPHOLIDOTUS Smith.

Holotype.

Type. EHT-HMS, No. 11149. Orig. EHT-HMS Field No. 1500. *Paratypes.* EHS-HMS Nos. 11141-11144, topotypes.*Publ.* Trans. Kansas Acad. Sci., 36, 1933, pp. 318-320.*Type loc.* Between Rincón and Cajones [Agua del Obispo], Guerrero, México. *Colls.*, H. M. Smith and E. H. Taylor, July 1, 1932.

GERRHONOTUS LEVICOLLIS CILIARIS Smith.

Paratype.

Paratypes. EHT-HMS, Nos. 10418-10421, San Felipe, Guanajuato, México.*Publ.* Proc. U. S. Nat. Mus., 92, 1942, pp. 365-367.*Type loc.* Sierra Guadalupe, Coahuila, México.

LEIOLOPISMA ASSATUM TAYLORI Oliver.

Paratype.

Paratypes. EHT-HMS, Nos. 10057-10058, km. 350, Agua del Obispo, Guerrero; Nos. 10048, near Mazatlán, 12 mi. S. Chilpancingo, Guerrero.*Publ.* Occ. Papers Mus. Zool. Univ. Michigan, No. 360, Nov. 20, 1927.*Type loc.* Santiago, Colima, México.

LEPIDOBLEPHARIS BARBOURI Noble.

Paratype.

Paratype. EHT-HMS, No. 29737-29738, Bella Vista, N.W. Perú. [Exc. M. C. Z. Harvard Coll.]*Publ.* ———.*Type loc.* ———.

LEPIDOPHYMA SMITHII TEHUANAE Smith.

Paratype.

Paratype. EHT-HMS, No. 28136, Tres Cruces, Oaxaca, México.*Publ.* Proc. U. S. Nat. Mus., 92, 1942, pp. 377-378.*Type loc.* Cerro Arenal, 30 km. W. Tehuantepec, Oaxaca.

LYGOSOMA CHERRIEI STUARTI Smith.

Paratype.

Paratype. EHT-HMS, No. 29881 (HMS, No. 1780), Potrero Viejo, Veracruz, México.*Publ.* Proc. Biol. Soc. Washington, 54, Dec. 8, 1941, p. 181.*Type loc.* Potrero Viejo, Veracruz, México.

PHYLLODACTYLUS HOMOLEPIDURUS Smith.

Holotype.

Type. EHT-HMS, No. 10853. Originally Field No. 146. *Paratypes.* EHT-HMS, Nos. 10849-10850, topotypes; Nos. 10851-10852; 10854-10874, Guaymas and La Posa; Nos. 10875-10876, between Empalme and Guaymas, Sonora.*Publ.* Univ. Kansas Sci. Bull., XXII, No. 6, 1935 (Nov. 15), pp. 121-125, pl. XXV, fig. 2; text fig. 1A.*Type loc.* Five mi. S.W. Hermosillo, Sonora, México. *Coll.*, Edward H. Taylor, June 22, 1934.

PHYLLODACTYLUS LANEI Smith.

Holotype.

Type. EHT-HMS, No. 10942. Originally EHT-HMS, Field No. 1461.
Paratypes. EHT-HMS, No. 11015-11022, 1 mi. N. Organos, Gro.; 11023-11034, Tierra Colorado, Gro.

Publ. Univ. Kansas Sci. Bull., Vol. XXII, No. 6, 1935 (Nov. 15), pp. 125-132, pl. XXV, fig. 3, text fig. 1B.

Type loc. Near Tierra Colorada, Guerrero, México. *Colls.*, Edward H. Taylor and Hobart M. Smith, June 30, 1932.

[Certain of the original series of paratypes have been referred to *Phyllo-dactylus magna* Taylor.]

PHYLLODACTYLUS MAGISTER Noble.

Paratype.

Paratypes. EHT-HMS, Nos. 29739-29740, topotypes. [Exc. M. C. Z. Harvard Coll.]

Publ. Occ. Papers Boston Soc. Nat. Hist., 5, 1924, p. 110.

Type loc. Perico, Chinchipe R., Perú.

SCELOPORUS AEENEUS BICANTHALIS Smith.

Holotype.

Type. Field Mus., No. ——. Orig. EHT-HMS, No. 7939. *Paratypes.* EHT-HMS, Nos. 7919, 7933, 7935, topotypes.

Publ. Occ. Pap. Mus. Zool., Univ. Mich., No. 361, Dec. 15, 1937, pp. 6-8.

Type loc. Cofre de Perote, near Cruz Blanca, Veracruz, México. *Coll.*, Edward H. Taylor.

SCELOPORUS CAUTUS Smith.

Holotype.

Type. Field Mus., No. ——. [Orig. EHT-HMS, No. 13027.] *Paratypes.* EHT-HMS, Nos. 13025, 30 mi. N. Matchuala S. L. P.: Nos. 13051, 53, La Colorada, Zac.; 13055, 57, 59, 61, 10 mi. S. Majoma, Zac.

Publ. Occ. Pap. Mus. Zool., Univ. Michigan, No. 387, Oct. 31, 1938, pp. 2-7.

Type loc. Thirty mi. N. El Salado (San Luis Potosí) in the state of Coahuila, México. *Colls.*, E. H. Taylor and Hobart M. Smith, Aug. 21, 1932.

SCELOPORUS CARINATUS Smith.

Holotype.

Type. Field Mus., No. ——. Orig. EHT-HMS, Field No. 4866.

Publ. Proc. Biol. Soc. Washington, 49, July 3, 1936, pp. 89-92, pl. II, figs. 2, 3.

Type loc. Near Tuxtla Gutierrez, Chiapas, México. *Colls.*, E. H. Taylor and Hobart M. Smith, Sept. 4, 1935.

SCELOPORUS EDWARDTAYLORI Smith.

Holotype.

Type. EHT-HMS, No. 8331. [Orig. EHT-HMS, No. 4221.] *Paratypes.* 8311, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, Totolapam, Oaxaca; 8333, topotype.

Publ. Herpetologica, Vol. 1, 1936, pp. 6-8.

Type loc. Near Ixtepec (San Gerónimo), Oaxaca, México. *Colls.*, E. H. Taylor and H. M. Smith, Aug. 7, 1935.

SCELOPORUS FORMOSUS SCITULUS Smith.

Holotype.

Type. EHT-HMS, No. 26962. *Paratypes.* EHT-HMS, Nos. 26956-26961; 26963-26975.

Publ. Proc. U. S. Nat. Mus., 92, 1942 (No. 3153), pp. 352-354.

Type loc. Omilteme, Guerrero [about 4 mi. E.]. *Coll.*, E. H. Taylor, Aug. 2-4, 1940. [Richard C. Taylor did not collect at Omilteme.]

- SCELOPORUS HORRIDUS ALBIVENTRIS** Smith. Holotype.
Type. EHT-HMS, No. 8519. *Paratypes.* 8511A, B, 13, 15, 17, topotypes.
Publ. Zoöl. Ser. Field Mus. Nat. Hist., 26, July 21, 1939, pp. 108-110.
Type loc. Tepic, Nayarit, México.
- SCELOPORUS JARROVII IMMUCRONATUS** Smith. Holotype.
Type. EHT-HMS, No. 9358A. [Orig. EHT-HMS, Field No. 500.] EHT-HMS, Nos. 5357-9367 (uneven numbers only), topotypes. 9368-9378, uneven numbers only, 25 mi. S. Jacala, Hgo.
Publ. Copeia, 1936 (Dec. 31), pp. 223-227.
Type loc. Ten mi. N. El Pinalito, Hidalgo, México. *Colls.*, Edward H. Taylor and Hobart M. Smith, June 15, 1932.
- SCELOPORUS JARROVII OBERON** Smith and Brown. Paratype.
Paratypes. EHT-HMS, Nos. 26916-26939, Mt. Zapalinamé, near Saltillo, Coahuila, México.
Publ. Zoöl. Ser. Field Mus. Nat. Hist., 24, No. 23, Aug. 30, 1941, pp. 253-257, fig. 24.
Type loc. Arteaga, Coahuila, México.
- SCELOPORUS JARROVII SUGILLATUS** Smith. Paratype.
Paratypes. EHT-HMS, Nos. 22311-22321.
Publ. Proc. U. S. Nat. Mus., 92, 1942, pp. 357-359.
Type loc. Lake No. 4, Zempoala, México, México.
- SCELOPORUS LINEOLATERALIS** Smith. Holotype.
Type. Field Mus., No. —. Orig. EHT-HMS, Field No. 4323. *Paratypes.* Uneven numbers, EHT-HMS, between 9380-9404.
Publ. Proc. Biol. Soc. Washington, 49, July 3, 1936, pp. 92-95.
Type loc. Six miles N.E. Pedriceña, Durango, México. *Colls.*, Edward H. Taylor and Hobart M. Smith, Aug. 27, 1932.
- SCELOPORUS LUNDELLI GAIGEAE** Smith. Paratype.
Paratype. EHT-HMS, No. 9943, topotype.
Publ. Zoöl. Ser. Field Mus. Nat. Hist., 26, July 27, 1939, pp. 71-74.
Type loc. Mérida, Yucatán, México.
- SCELOPORUS LUNDELLI LUNDELLI** Smith. Paratype.
Paratypes. EHT-HMS, Nos. 9945, 47, 49, 51, 53, 55, Balchacaj, Campeche.
Publ. Zoöl. Ser. Field Mus. Nat. Hist., 26, July 27, 1939, pp. 66-71.
Type loc. Cohune Ridge (20 mi. S.E. Benque Viejo), British Honduras.
- SCELOPORUS MACULOSUS** Smith. Holotype.
Type. Field Mus., No. —. [Orig. EHT-HMS, Field No. 4483.] *Paratypes.* EHT-HMS, Nos. 7643, 6 mi. N.E. Pedriceña; 7645, 7647, 14 mi. N.E. Pedriceña.
Publ. Trans. Kansas Acad. Sci., Vol. 37, 1934, pp. 267-269, pl. VIII, figs. 2, 4, 5; pl. X, fig. 11.
Type loc. Fourteen mi. N.E. Pedriceña, Durango, México. *Colls.*, Edward H. Taylor and Hobart M. Smith, Aug. 29, 1932.

SCELOPORUS MEGALEPIDURUS Smith.

Holotype.

Type. EHT-HMS, No. 7543. Orig. EHT-HMS, Field No. 2908. *Paratypes.* EHT-HMS, uneven numbers between 7500-7610.

Publ. Trans. Kansas Acad. Sci., 37, 1934, pp. 272, 274-277, pl. IX, figs. 7, 8; pl. X, fig. 13.

Type loc. Near Totalco, Veracruz, México. *Colls.*, Edward H. Taylor and Hobart M. Smith, July 19, 1932.

SCELOPORUS MELANORHINUS CALLIGASTER Smith. Paratype.

Paratypes. EHT-HMS, Nos. 8267, 8269, Queseria, Colima; Nos. 8271, 73, 73A, 75, 77, Hda. Paso del Río, Colima; Nos. 8279, 82, 83, 85, 87, 89, 91, 93, 97, 99, Hda. El Sabino, Michoacán; Nos. 8301, 03, 05, 07, 09, El Treinte, Guerrero.

Publ. Proc. U. S. Nat. Mus., 92, 1942, pp. 360-361, fig. 38.

Type loc. Acapulco, Guerrero, México.

SCELOPORUS MERRIAMII ANNULATUS Smith.

Holotype.

Type. EHT-HMS, No. 29882. [Orig. EHT, A 787.]

Publ. Proc. Biol. Soc. Washington, 50, June 22, 1937, pp. 83-86.

Type loc. East slope Chisos Mts., Brewster County, Texas, U. S. A. *Colls.*, Edward H. Taylor and John Suarez Wright.

SCELOPORUS MUCRONATUS AUREOLUS Smith.

Paratype.

Paratypes. EHT-HMS, uneven numbers between 9189-9216. [Formerly EHT-HMS, Field Nos. 3073-3080, 3082, 3102, 3171-3174, 3193-3195.] Topotypes.

Publ. Proc. U. S. Nat. Mus., 92, No. 3153, 1942, pp. 356-357.

Type loc. Two mi. W. Acultzingo, Veracruz, México.

SCELOPORUS OCHOTERENAE Smith.

Holotype.

Type. EHT-HMS, No. 7158. [Orig. EHT-HMS, Field No. 1075.] *Paratypes* (37), all uneven numbers between 7135-7207. Various localities in Guerrero, México.

Publ. Trans. Kansas Acad. Sci., 37, 1934, pp. 267-269, pl. IX, figs. 6, 9; pl. X, fig. 12.

Type loc. Two mi. N. Mazatlán (12 mi. S. Chilpancingo), Guerrero, México. *Colls.*, Edward H. Taylor and Hobart M. Smith.

SCELOPORUS OLIVACEUS Smith.

Holotype.

Type. EHT-HMS, No. 29883. [Orig. EHT, Field No. 2508.]

Publ. Trans. Kansas Acad. Sci., 37, 1935, pp. 277-279.

Type loc. Arroyo Los Olmos, 3 mi. S. E. Rio Grande City, Texas. *Colls.*, E. H. Taylor and John S. Wright, Aug. 23, 1931.

SCELOPORUS PARVUS Smith.

Holotype.

Type. EHT-HMS, No. 7120. [Orig. EHT-HMS, Field No. 292.] *Paratypes.* EHT-HMS, 7119-21, 23, 25, 31, 33.

Publ. Trans. Kansas Acad. Sci., Vol. 37, 1934, pp. 263-267, pl. VIII, figs. 1, 3; pl. X, fig. 10.

Type loc. Five mi. W. Sabinas Hidalgo, Nuevo León, México. *Colls.*, Edward H. Taylor and Hobart M. Smith, June 8, 1932.

SCELOPORUS PARVUS SCUTULATUS Smith.

Holotype.

Type. EHT-HMS, No. 7129. *Paratype.* EHT-HMS, No. 7127, topotype.*Publ.* Occ. Pap. Mus. Zool., Univ. Michigan, No. 358, Oct. 30, 1937, pp. 4-6.*Type loc.* Thirty mi. N. Matahuala, San Luis Potosí, México. *Colls.*, E. H. Taylor and H. M. Smith, Aug. 20, 1932.

SCELOPORUS SCALARIS UNICANTHALIS Smith.

Holotype.

Type. EHT-HMS, No. 7699.*Publ.* Occ. Papers Mus. Zool., Univ. Michigan, No. 361, Dec. 15, 1937, pp. 4-5.*Type loc.* Magdalena, Jalisco, México. *Coll.*, Hobart M. Smith, June 30, 1935.

SCELOPORUS SERRIFER PLIOPORUS Smith.

Paratype.

Paratypes. EHT-HMS, Nos. 9417, topotype; 9409, 11, 13, 15, 5 mi. E. Jalapa, Veracruz; 9405, 9407, Las Vigas, Veracruz.*Publ.* Zool. Ser. Field Mus. Nat. Hist., 26, 1939, pp. 212-213.*Type loc.* Four mi. E. Encero, Veracruz, México.

SCELOPORUS SPINOSUS CAERULEOPUNCTATUS Smith. Paratype.

Type. Field Mus., No. ——. [Orig. EHT-HMS, No. 8467.] *Paratype.* EHT-HMS, No. 8465, topotype.*Publ.* Univ. Kansas Sci. Bull., Vol. XXIV, No. 18, 1936 (Feb. 16, 1938), pp. 471-473.*Type loc.* Slopes of Cerro San Luis, about 15 mi. N. Oaxaca, Oaxaca, México. *Coll.*, Hobart M. Smith, Aug. 5, 1935.

SCELOPORUS STEJNEGERI Smith.

Paratype.

Type. EHT-HMS, Nos. 22285-22287; 27299-27301; topotypes.*Publ.* Proc. U. S. Nat. Mus., 92, 1942, pp. 350-352.*Type loc.* Tierra Colorada, Guerrero, México.

SCELOPORUS VARIABILIS SMITHI Hartweg and Oliver.

Paratype.

Paratype. EHT-HMS, Nos. 7875, 7877, topotypes.*Publ.* Occ. Papers Mus. Zool. Univ. Michigan, No. 356, 1937, pp. 1-5.*Type loc.* Guengola Mountain, 6 km. N. W. Tehuantepec, Oaxaca, México.TROPIDOPHORUS LAOTUS M. Smith = *Tropidophorus berdmorei laotus* (M. Smith).

Cotypes.

Cotypes. EHT-HMS, Nos. 29887-29888, topotypes. Formerly M. Smith, Nos. 5443, 5571. [Exc. Malcolm Smith.]*Publ.* Proc. Zool. Soc. London, Dec., 1923, pp. 777-778.*Type loc.* Muang Liep, N. of Pak Lai, Upper Mekong, French Laos.

UTA TAYLORI Smith.

Holotype.

Type. EHT-HMS, No. 10692. Originally EHT-HMS, Field No. 320a. *Paratypes.* 10680-10682, 54 mi. S.W. Hermosilla; 10683-10691A; 10693-10702, topotypes.*Publ.* Univ. Kansas Sci. Bull., Vol. XXI, No. 7, 1935 (Nov. 15), pp. 158-166, pl. XXVI, fig. 3.*Type loc.* Ten mi. M. W. Guaymas, Sonora, México. *Coll.*, E. H. Taylor, July 3, 1934.

SERPENTES

ADELPHICOS VERAEPACIS NIGRILATUS Smith. Holotype.
Type. EHT-HMS, No. 15335. *Paratypes.* Nos. 15331-4; 15336-42, all topotypes.

Publ. Proc. Rochester Acad. Sci., 8, Sept. 10, 1942, pp. 182-186, fig. 1.

Type loc. San Cristobal, Chiapas, México. *Coll.*, H. Devlin Thomas.

CLELIA CLELIA IMMACULATA Smith. Paratype.

Paratype. EHT-HMS, No. 4568, Paso del Río, Colima, México.

Publ. Proc. U. S. Nat. Mus., 92, 1942, p. 394.

Type loc. "Guadalajara," Jalisco, México.

CONIPHANES FISSIDENS DISPERSUS Smith. Holotype.

Type. EHT-HMS, No. 5531. *Paratype.* No. 5532, topotype.

Publ. Proc. U. S. Nat. Mus., 91, No. 3127, 1941, pp. 106-107.

Type loc. El Limoncito [near La Venta], Guerrero, México.

CROTALUS TRISERIATUS ANAHUACUS Gloyd. Paratype.

Paratypes. EHT-HMS, Nos. 5492, near Tres Cumbres (km. 43), D. F.; 5473-5474, Lake of Zampoala, Morelos, México.

Publ. The Rattlesnakes genera *Sistrurus* and *Crotalus*, Chicago Acad. Sci., Sp. Publ. No. 4, 1940, pp. 91-95.

Type loc. "Valley of México."

DENDROPHIDION VINITOR Smith. Paratype.

Paratypes. EHT-HMS, Nos. 27496-27498, La Gloria, Oaxaca, México.

Publ. Proc. Biol. Soc. Washington, 54, 1941, pp. 73-76,

Type loc. Piedras Negras, Petén, Guatemala.

DRYMARCHON CORAIS RUBIDUS Smith. Paratype.

Paratypes. EHT-HMS, No. 5405, Puente de Ixtla, Morelos [near Huajintlan, km. 133]; No. 5400, Magdalena, Jalisco; Nos. 5331, 5406, El Sabino, Michoacán; No. 5591, Huajintlán, Guerrero; No. 21514, Guerrero.

Publ. Journ. Washington Acad. Sci., 31, No. 11, Nov. 15, 1941, pp. 474-476.

Type loc. Rosario, Sinaloa, México.

DRYMARCHON CORAIS UNICOLOR Smith. Paratype.

Paratype. EHT-HMS, No. 29876 (HMS, 14556), topotype.

Publ. Journ. Washington Acad. Sci., 31, No. 11, Nov. 15, 1941, pp. 470-472.

Type loc. La Esperanza, near Escuintla, Chiapas, México.

DRYMOBIUS MARGARITIFERUS FISTULOSUS Smith. Paratype.

Paratypes. EHT-HMS, No. 4607, Paso del Río, Colima; Nos. 4708, 5363-5365, Hda. El Sabino, near Uruapan, Michoacán; No. 4613, Cuernavaca, Morelos; No. 5366, Ocotito, Guerrero; No. 23627, Tierra Colorada, Guerrero, México.

Publ. Proc. U. S. Nat. Mus., 92, 1942, pp. 383-384.

Type loc. Miramar, Nayarit, México.

I.EPTODEIRA ANNULATA TAYLORI Smith. Paratype.

Paratype. EHT-HMS, No. 4618, Acultzingo, Veracruz, México.

Publ. Proc. Biol. Soc. Washington, 54, Sept. 30, 1941, pp. 115-117.

Type loc. Orizaba, Veracruz, México.

LEPTOTYPHLOPS BAKEWELLI Oliver.

Paratype.

Paratype. EHT-HMS, No. 5477, topotype.*Publ.* Occ. Papers Mus. Zoöl. Univ. Michigan, No. 36, Nov. 20, 1937, pp. 16-18, fig. 1.*Type loc.* Paso del Río, Colima.**MASTICOPHIS FLAGELLUM LINEATULUS** Smith.

Paratype.

Paratype. EHT-HMS, No. 5388, between Torreon and San Pedro, Coahuila, México.*Publ.* Journ. Washington Acad. Sci., 31, No. 9, Sept. 15, 1941, pp. 394-397.*Type loc.* Eleven mi. S. San Buenaventura, Chihuahua, México.**MASTICOPHIS TAENIATUS AUSTRALIS** Smith.

Paratype.

Paratype. EHT-HMS, No. 26227, Tacicuaró, Michoacán, México.*Publ.* Journ. Washington Acad. Sci., 31, No. 9, Sept. 15, 1941, pp. 390-392.*Type loc.* "Guanajuato."**MICRURUS FITZINGERI MICROGALBINEUS** Brown and Smith.

Holotype.

Type. EHT-HMS, No. 27847. *Paratype.* EHT-HMS, No. 5515, 18 km. N. Valles, San Luis Potosí *Coll.*, E. H. Taylor*Publ.* Proc. Biol. Soc. Washington, 55, June 25, 1942, pp. 63-66*Type loc.* Seven km S. Antiguo Morelos, Tamaulipas, México. *Coll.*, Bryce C. Brown, June 21, 1942.**NINIA DIADEMATA FLORATOR** Smith.

Holotype.

Type. EHT-HMS, No. 23557.*Publ.* Copeia, 1942, No. 3, Oct. 8, pp. 153-154.*Type loc.* Durango, Hidalgo, México. *Coll.*, Radclyffe Roberts (not E. H. Taylor as stated in the type description, *loc. cit.*).**PLIOCERCUS ELAPOIDES LATICOLLARIS** Smith.

Paratype.

Paratypes. EHT-HMS, No. 11642, Tres Brazos, Campeche, and No. 11643, Encarnación, Campeche.*Publ.* Proc. Biol. Soc. Washington, 54, Sept. 30, 1941, pp. 122-123.*Type loc.* Chichen Itza, Yucatán, México.**PLIOCERCUS ELAPOIDES SCHMIDTI** Smith.

Paratype.

Paratypes. EHT-HMS, No. 11642, Tres Brazos, Campeche, and 11643, Encarnación, Campeche. [Orig. referred to *P. e. laticollaris* Smith.]*Publ.* Proc. Biol. Soc. Washington, 55, Oct. 17, 1942, pp. 161-162.*Type loc.* Chichen Itza, Yucatán, México.**RHADINAEA AEMULA** Bailey.

Paratype.

Paratypes. EHT-HMS, No. 5218, Tres Marias, Morelos; No. 5219, 10 km. N. Cuernavaca, Morelos, [elev., about 7500 ft.].*Publ.* Occ. Papers Mus. Zoöl. Univ. Michigan, No. 412, May 6, 1940, pp. 4-5, pl. 1, fig. 3.*Type loc.* Omilteme and Sierra de Burro, Guerrero, México.

RHADINAEA CRASSA Smith.

Holotype.

Type. EHT-HMS, No. 5526. *Paratype.* EHT-HMS, No. 23548.*Publ.* Proc. Biol. Soc. Washington, 55, 1942, pp. 190-191, figs. 4, 5.*Type loc.* Durango, Hidalgo, México.**RHADINAEA FORBESI** Smith.

Paratype.

Paratype. EHT-HMS, No. 23956, topotype. [Orig. HMS, No. 13211]*Publ.* Proc. Biol. Soc. Washington, 55, 1942, pp. 188-189.*Type loc.* Tequeyutepec, 7 mi. W. Jalapa, Veracruz.**RHADINAEA HESPERIA** Bailey.

Paratype.

Paratypes. EHT-HMS, Nos. 5444, El Treinte, Guerrero. Nos. 5441-5442, Hacienda El Sabino, Michoacán.*Publ.* Occ. Papers Mus. Zool. Univ. Michigan, No. 412, May 6, 1940, pp. 4-5, pl. 1, fig. 3.*Type loc.* Omilteme and Sierra de Burro, Guerrero, México.**RHADINAEA HESPERIA BAILEYI** Smith

Holotype.

Type. EHT-HMS, No. 5444.*Publ.* Proc. Biol. Soc. Washington, 55, Dec. 31, 1942, pp. 187-188, fig. 2.*Type loc.* El Treinte, Guerrero, México. *Coll.*, E. H. Taylor, Aug. 1, 1936.**RHADINELLA SCHISTOSA** Smith.

Genotype—Holotype.

Type. EHT-HMS, No. 23580. *Paratypes.* EHT-HMS, Nos. 23571, 23577-23579, 23581, topotypes.*Publ.* Copeia, 1941, No. 1, March 25, pp. 7-10, fig. 1.*Type loc.* Cuautlapan, Veracruz, México. *Coll.*, E. H. Taylor, Aug., 1940.**SALVADORA INTERMEDIA** RICHARDI Smith.

Holotype.

Type. EHT-HMS, No. 23470.*Publ.* Smithsonian Misc. Coll. 99, No. 20, Feb. 21, 1941, pp. 6-9, fig. 5.*Type loc.* One mile N. Tehuacán, Puebla, México. *Coll.*, Richard Clark Taylor, Aug. 8, 1940.**TANTILLA PHRENITICA** Smith.

Paratype.

Paratypes. EHT-HMS, No. 22367, El Limón (Totalco), Veracruz; EHT-HMS, Nos. 23561-70, 23572-76, 23582 (topotypes), Cuautlapan, Veracruz.*Publ.* Zoologica, 27, No. 7, 1942, p. 39.*Type loc.* Cuautlapan, Veracruz, México.**TANTILLA WILCOXI RUBRICATA** Smith.

Paratype.

Paratype. EHT-HMS, No. 23473, Mt. Zapalinamé, Saltillo, Coahuila, México.*Publ.* Zoologica, 27, 7, 1942, pp. 40-41.*Type loc.* Fifteen mi. S.E. Galeana, Nuevo León, México.**THAMNOPHIS EQUUS POSTREMUS** Smith.

Holotype.

Type. EHT-HMS, No. 5275. *Paratypes.* 5274, 5285-5286, Uruapan, Michoacán.*Publ.* Zoologica, XXVII, pts. 3 and 4, Oct. 23, 1942, pp. 109-110.*Type loc.* El Sabino, Michoacán. *Coll.*, H. M. Smith.

THAMNOPHIS MELANOGASTER CANESCENS Smith. Holotype

Type. EHT-HMS, No. 5023. *Paratypes* EHT-HMS, Nos 4896, 4921, 4923-32, 4928A, 4934, 4936, 4939-41, 4942A, 4943, 4967-73, 4970A, 5020-22, 5024-43, all topotypes No 5019, Magdalena, Jalisco, Nos 5064-65, Lake Cuitzeo, Michoacán; Nos 5066-71, 8 mi E Celaya, Guanajuato

P bl. Zoologica XXVII, pts 3-4, No 17, Oct 23, 1942, pp 117-120

Type loc Lake Chapala, Chapala, Jalisco, México *Coll*, H M Smith, July 2, 1935

THAMNOPHIS VICINUS Smith Holotype

Type EHT-HMS, No 21539 *Paratypes* 15897, topotype, 15893-15896, 15992-15995, Morelia, Michoacán

Pub Zoologica, XXVII, pts 3 and 4, Oct 23 1942 pp 104-106

Type loc Near Temaxcal Michoacán, 20 km E Morelia *Coll*, E H Taylor, Aug, 1939

TRIMERESURUS GARCIAE Smith [= *Trimeresurus melanurus* Muller]

Holotype

Type EHT-HMS No 24353 Orig Dyfrig M Forbes Coll No 882

Paratype EHT-HMS, No 21489 topotype

Publ Proc Biol Soc Washington, 53, April 19 1940, pp 62-63, fig 2

Type loc Neu Cacoloapam, Puebla, México *Coll*, Dyfrig McH Forbes, 1939

XENODON MEXICANUS Smith Paratype

Paratype EHT-HMS No 5207 Potrero Viejo Veracruz México

Publ Proc Biol Soc Washington 53 April 19 1940 pp 57-59

Type loc Piedras Negras Guatemala

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The Genera of Plethodont Salamanders in Mexico, Pt. I.

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ABSTRACT: The old genus *Oedipus* Tschudi (preoccupied by *Oedipus* Berthold, for a genus of Orthoptera, is considered as being composed of eight genera: *Chiropterotriton* gen. nov., *Pseudoeurycea* gen. nov., *Bolitoglossa* Duméril and Bibron, *Parvimolge* gen. nov., *Thorius* Cope, *Oedipina* Keferstein, *Magnadigita* gen. nov., and *Haptoglossa* Cope.

INTRODUCTION

DURING the past twelve years, at occasional intervals, I have taken the opportunity to inquire into some of the more evident problems concerning Mexican lungless salamanders. In this length of time a rather surprising number of errors and additions to previous studies have come to light. Some have been recorded already; these and others are here summarized.

Until recently I followed Dr. Emmett Dunn in his use of the generic name *Oedipus* Tschudi for the group. Then, after Dr. Radclyffe Roberts pointed out to me that *Oedipus* Tschudi (1838) was preoccupied by *Oedipus* Berthold (1827) for an orthopteran genus, I recorded the suppression of Tschudi's name in the University of Kansas Science Bulletin, Vol. 26, No. 12, 1939 (1940), first submitting the case to the late Dr. Leonhard Stejneger, formerly a member of the International Commission on Zoölogical Nomenclature, who agreed that *Oedipus* Tschudi is not available.

In the same paper I revived Cope's genus *Thorius* for certain small Mexican salamanders, formerly associated with *Oedipus*, and used *Bolitoglossa* Duméril and Bibron for the remaining species in lieu of *Oedipus*.

A superficial examination of the numerous species of plethodontid

salamanders occurring in México, Central America and South America, showed the urgent necessity of a critical examination of these salamanders with a view of ascertaining whether Dunn was correct in lumping the thirty-one species treated in his "The Salamanders of the Family Plethodontidae" into a single genus, or whether they represented several genera and should be allocated accordingly. Early in my studies the existence of certain superspecific groups, not exactly those of Dunn, was recognized, and with the discovery of many new species by Mr. Karl P. Schmidt, Dr. L. C. Stuart, Dr. Hobart M. Smith, and myself, these groups took on more importance.

Unwilling to accept them as genera without more convincing evidence, in spite of their apparent distinctness, I embarked upon an investigation of their internal characters. In them, I found many strikingly distinctive features, correlated so completely with the groups already outlined that the existence of several genera in the *Oedipus* of Dunn (and others) became, in my opinion, an established fact.

The specimens of "*Oedipus*" which Dunn had available numbered 718, and 31 species were recognized. Compared to this number, I have examined more than eight times as many (something more than 6,000 specimens), chiefly in the collections made by Dr. Hobart M. Smith and myself, together with a considerable number of specimens in the Field Museum, Museum of Zoölogy of the University of Michigan, Museum of Comparative Zoölogy at Harvard College, American Museum of Natural History, and the United States National Museum.*

In this paper I am considering seventy-eight species † and subspecies, all known to the present, from the Americas south of the United States. This is two and one-half times the number of species recognized by Doctor Dunn. Certain of those that he did not recognize, were actually available to him, but were confused with other species. On the other hand, many have been discovered since the publication of his work. For some of the genera into which these species are here segregated, new generic names are required and are proposed herein.

It may be assumed that had all the species and material I have examined been available to him, Doctor Dunn would have arrived at much different conclusions from those expressed in his monograph.

* I desire to express my hearty thanks to the officials of these institutions who have made loans and exchanges of plethodontid salamanders and to Dr. Hobart M. Smith, who permitted me to study the material contained in the Mexican collection made by him and who has offered able advice in the preparation of this paper.

† I have seen two other species still undescribed.

The list of species recognized in this paper follows.

<i>adpersa</i> Peters	<i>macrinii</i> Lafrentz
<i>ahli</i> Unterstein	<i>melanomolge</i> Taylor
<i>alfaroi</i> Dunn	<i>mexicana</i> Duméril and Bibron
<i>altamazonica</i> Cope	<i>moauei</i> Woodall
<i>altamontana</i> Taylor	<i>morio</i> Cope
<i>arborea</i> Taylor	<i>mulleri</i> Brocchi
<i>barbouri</i> Schmidt	<i>multidentata</i> Taylor
<i>bellii</i> Gray	<i>narisovalis</i> Taylor
<i>borburata</i> Trapido	<i>nasalis</i> Dunn
<i>bromeliacea</i> Schmidt	<i>nigroflavescens</i> Taylor
<i>cephalica cephalica</i> Cope	<i>nigromaculata</i> Taylor
<i>cephalica manni</i> Taylor	<i>occidentalis</i> Taylor
<i>cephalica rubrinembris</i> Taylor and Smith	<i>odonnelli</i> Stuart
<i>chiroptera</i> Cope	<i>paraensis</i> Unterstein
<i>chondrostega</i> Taylor	<i>parvipes</i> Peters
<i>cochranae</i> Taylor	<i>pennatula</i> Cope
<i>collaris</i> Stejneger	<i>peruviana</i> Boulenger
<i>colonnea</i> Dunn	<i>picadoi</i> Stejneger
<i>complez</i> Dunn	<i>platydactyla</i> Cuvier
<i>cuchumatana</i> Stuart	<i>pressicauda</i> Cope
<i>dimidiata</i> Taylor	<i>pulmonaris</i> Taylor
<i>doffleini</i> Werner	<i>rez</i> Dunn
<i>dubita</i> Taylor	<i>robertsi</i> Taylor
<i>dunni</i> Schmidt	<i>robusta</i> Cope
<i>elongata</i> Schmidt	<i>rostrata</i> Brocchi
<i>englehardti</i> Schmidt	<i>rufescens</i> Cope
<i>flavimembris</i> Schmidt	<i>salvinii</i> Gray
<i>flaviventris</i> Schmidt	<i>schmidti</i> Dunn
<i>franklini</i> Schmidt	<i>smithi</i> Taylor
<i>gadovii</i> Dunn	<i>striatula</i> Noble
<i>galeanae</i> Taylor	<i>subpalmata</i> Boulenger
<i>gigantea</i> Taylor	<i>sulcata</i> Brocchi
<i>goebeli</i> Schmidt	<i>terrestris</i> Taylor
<i>helmrichi</i> Schmidt	<i>townsendi</i> Dunn
<i>lavae</i> Taylor	<i>trogodytes</i> Taylor
<i>leprosa</i> Cope	<i>uniformis</i> Kesterstein
<i>lignicolor</i> Peters	<i>unguidentis</i> Taylor
<i>lincolni</i> Stuart	<i>yucatanica</i> Peters
<i>lineola</i> Cope	<i>zolocatae</i> Taylor

The following names have been proposed for species which have been referred to other known forms. Having seen but one of these types, I have no personal opinion as to the wisdom of certain of these synonymies. It is quite probable that some of these are good species. However, the types, if extant, will of necessity have to be carefully examined before the matter can be finally settled.

andicola = *adpersa* Peters (*fide* Dunn)
attitlanensis Brocchi = *salvinii* Gray (*fide* Schmidt)
bocourti Boulenger = *robusta* Cope (*fide* Dunn)
bocourti Brocchi = *rostrata* Brocchi (*fide* Dunn)
carbonaria Cope = *platydactyla* Cuvier (*fide* Dunn)
copei Brocchi = *platydactyla* Cuvier (*fide* Dunn)
estheri (*Eladinea*) Ribero = *altamazonica* (*fide* Parker)

gibbicaudus Blatchley = *leprosa* Cope (Based on same type)
infuscata Peters = *lineola* Cope (*fide* Dunn)
laticeps Brocchi = *cephalica* Cope (*fide* Dunn)
minima Wiedersheim = *pennatulus* Cope (*fide* Dunn)
orcula Cope = *chiroptera* Cope (*fide* Cope)
orizabensis Blatchley = *leprosa* Cope
palmata Werner = *altamazonica* Cope (*fide* Dunn)
simus Valliant = *altamazonica* Cope (*fide* Dunn)
togata Valenciennes (*nomen nudum*)
yucatanica Boulenger = *yucatanica* Peters
punctatum = *platydactyla* Cuvier (*fide* Dunn)

REVIEW OF CLASSIFICATION SYSTEMS

In the past seventy-five years the classification of the lungless salamanders having a nasolabial groove has undergone few changes other than the addition of newly discovered species and genera. Edward Drinker Cope in 1869 presented a complete classification of the group in a paper† entitled, "A Review of the Species of the Plethodontidae and Desmognathidae." While this system was based on previous systems to some extent, Cope himself had investigated the anatomy of a great many of the forms concerned. His arrangement follows:

FAMILY PLETHODONTIDAE

Genus <i>Plethodon</i>	Genus <i>Gyrinophilus</i>
Genus <i>Hemidactylum</i>	Genus <i>Manculus</i>
Genus <i>Batrachoseps</i>	Genus <i>Opheobatrachus</i>
Genus <i>Stereocheilus</i>	Genus <i>Oedipus</i>
Genus <i>Anaides</i>	Genus <i>Spelerpes</i>
Genus <i>Geotriton</i>	

FAMILY DESMOGNATHIDAE

Genus *Desmognathus*

FAMILY THORIIDAE

Genus *Thorius*

G. A. Boulenger, in his Catalogue of the Batrachia Gradientia s Caudata and Batrachia Apoda in the collection of the British Museum, 2d Ed., 1822, pp. 51-79, treats of the same group of salamanders under two subfamilies of the Family SALAMANDRIDAE as follows:

FAMILY SALAMANDRIDAE

[Subfamily A SALAMANDRINAE]

[Subfamily B AMBLYSTOMATINAE]

† Proc. Acad. Nat. Sci. Philadelphia, 1869, pp. 98-118.

Subfamily C PLETHODONTINAE

- Genus *Anaides*
- Genus *Plethodon*
- Genus *Batrachoseps*
- Genus *Spelerpes*
- Genus *Manculus*

Subfamily D DESMOGNATHINAE

- Genus *Desmognathus*
- Genus *Thorius*

This system lowered two of Cope's families to subfamily rank, and the third family *Thoriidae* was ignored, the genus *Thorius* being placed under the DESMOGNATHINAE.

Again in 1889 in his great monograph on The Batrachia of North America, Cope published a classification, using practically the same arrangement as was used in 1869, which recognized the DESMOGNATHIDAE, PLETHODONTIDAE and THORIIDAE as full families. The generic conceptions remained practically the same.

During the four subsequent decades both writers had their followers. As late as 1925 the Zoölogical Record was using Boulenger's subfamilies; and the Check List of North American Amphibians and Reptiles of 1922 was using Cope's arrangements and families and genera, as far as they applied to the American Fauna.

Cope (1893) apparently modified his idea of the importance of Family THORIIDAE, from that published earlier, and on the occasion of describing *Haptoglossa** referred the genus to the Subfamily THORIINAE in which he also places *Thorius* and *Oedipina*. One is in doubt as to whether it was regarded as a subfamily of the PLETHODONTIDAE or the DESMOGNATHIDAE.

In 1900 Cope's family DESMOGNATHIDAE (Boulenger's Desmognathinae) met some criticism from Percy Moore,† who endeavored to show that the group DESMOGNATHIDAE was not separable from the PLETHODONTIDAE on the basis of the character of the vertebral articulations which he erroneously believed was the only character of significance separating the two families.

In 1917 a new family, TYPHLOMOLGIDAE, was proposed by Stejneger and Barbour‡ for the genus *Typhlomolge*. Although this genus was subsequently referred to the Family PLETHODONTIDAE, these authors originally placed the family in a different suborder, the *Proteida*.

* Cope, Proc. Amer. Phil. Soc., 31, 1893, p. 334.

† Proc. Acad. Nat. Sci. Philadelphia, 1900, pp. 613-622.

‡ A Check List of North American Amphibia and Reptilia, Harvard Press, 1917.

Dunn's work on "The Salamanders of the Family Plethodontidae" is the most recent monographic treatment. In it he followed Moore by placing Cope's family DESMOGNATHIDAE in the family PLETHODONTIDAE. However, he does point out in this work many significant differences which obtain between the two groups. He states "Moore in 1900 showed that the difference between amphicoelous and opisthocelous vertebrae was a matter of individual age, and that systematic divisions based on this character were worthless."

Further, Dunn places the THORIIDAE (THORIINAE) and the TYPHLOMOLGIDAE in the synonymy of the PLETHODONTIDAE.

The classification of the Plethodontidae used is as follows:

Family PLETHODONTIDAE

Genus Typhlomolge	Genus Ensatina
Genus Typhlotriton	Genus Plethodon
Genus Hemidactylum	Genus Gyrinophilus
Genus Batrachoseps	Genus Pseudotriton
Genus Stereochilus	Genus Eurycea
Genus Desmognathus	Genus Hydromantes
Genus Leurognathus	Genus Oedipus
Genus Aneides	

Among the generic changes proposed by Dunn, those treating of the salamanders south of the borders of the United States seem to be most open to question. Thus the genera *Oedipina*, *Oedipus*, *Haptoglossa*, and *Thorius* and certain forms referred by Cope and others to *Spelerpes*, are lumped together in the genus *Oedipus* Tschudi (preoccupied).

GENERAL CONSIDERATIONS

The salamanders of the family Plethodontidae, as interpreted by various recent authors, comprise a group extending from Alaska and Canada to Argentina and Bolivia, with a small remnant group occupying territory in Sardinia, southeastern France, and northwestern Italy. In the northern part of the range in the western hemisphere, the family has been broken up into a number of genera, about 17 being generally recognized at the present time, with some 79 species and subspecies. (Bishop, Handbook of Salamanders, 1943.)

Contrasting with this treatment in the north, most of the species occurring in México (exclusive of Baja California), Central and South America, have been thrown (following Dunn), into a single genus, which for the most part, has been recognized under the name *Oedipus* Tschudi (preoccupied by *Oedipus* Berthold for a genus of Orthoptera). The number of forms in this territory now known

number 80, and save for two, *Ensatina platensis* from Argentina and a *Batrachoseps attenuatus* in Colima, México, have been generally regarded as congeneric.

Dunn states that the large genus *Oedipus* (as he defines it) contains many extremes, and its range of variation exceeds that of most other genera so that definition of the genus is difficult—a statement which in itself strongly suggests that it is a composite. He further states that in the advent of the extinction of a few species, several genera (at least four) would be established.

Contrary to Dunn's statements, studies of the salamanders of his genus "*Oedipus*" demonstrate that he has included several generic groups, which, if all important characters are considered, form groups of equal importance and rank with the genera which he recognizes as occurring in the United States. These generic groups are not linked by annectant forms and are not "incipient" genera. If one were to unite all the plethodontid genera having a single premaxilla into a single genus or all of those having a free tongue into a genus, one would have groups no more heterogeneous than his "*Oedipus*."

Apparently Dunn made some effort to break up his genus "*Oedipus*." He arranges the species into four groups, of which he states: "They fall into the following groups, which would, if distinct enough and in the absence of annectant forms, rank as genera."

Group I. The primitive group, including*

<i>bellii</i>	<i>cephalicus</i>	<i>subpalmatus</i>	<i>chiropterus</i>
<i>schmidti</i>	<i>rostratus</i>	<i>adspersus</i>	<i>rex</i>
<i>robustus</i>	<i>morio</i>	<i>sulcatus</i>	

Group II. Small mountain forms with large nostrils.

<i>toungensis</i>	<i>nasalis</i>
<i>pennatululus</i>	<i>picadoi</i>

Group III. Species with fully webbed toes, almost all low country forms.

<i>altamazonicus</i>	<i>platydactylus</i>	<i>salvini</i>
<i>attitlanensis</i>	<i>hignicolor</i>	<i>yucatanus</i>
<i>striatulus</i>	<i>colonneus</i>	<i>rufescens</i>

Group IV. Wormlike forms, low country species with elongate bodies and weak limbs, usually lacking sexual dimorphism and the basal constriction of the tail.

<i>lineolus</i>	<i>complex</i>	<i>uniformis</i>
<i>collaris</i>	<i>parvipes</i>	<i>alfaroi</i>

* *gadovii* is not placed in a group, but had it been considered would probably be here.

If we examine Group I, we will observe that it is composed of an association of at least three widely different generic groups. Each of these has a different type of foot, and one group differs also in having the sublingual fold absent. *Adpersus* may even represent a fourth generic group, since it is said to lack a prefrontal and is reported to be ovoviviparous.†

In his Group II are again associated forms belonging to at least three widely differing generic groups. These, however, have in common an enlarged nostril. *Nasalis* is a member of the same generic group as *chiroptera* of Group I; *pennatulus* is a *Thorius* and his *townsendi* has no close relatives. I do not know *picadoi* by autopsy and I am uncertain of its generic reference.

In Group III we find species which have greater warrant for the association and probably are all referable to the same genus.

His Group IV includes six elongate forms, and while all are apparently quite distinct from other generic groups, may consist of more than a single genus. However, Dunn states, in speaking of *collaris*, "Has no near relatives. Remotely allied to *parvipes*, *collaris* is like it a link between the mass of the genus and the forms which have been considered *Oedipina*. The distinction is broken down and I can no longer regard the latter genus as tenable." I am not clear what breaks down the distinction.

Concerning *parvipes* he says, "This animal breaks down the distinction between *Oedipus* and *Oedipina*. It is related to the more degenerate *alfaroi* of Costa Rica. The small eye, the long snout, the brown color, are the same in both. But *alfaroi* has 20 costal grooves as against 17 in *parvipes*, and there are no teeth on the maxilla."

If we examine some of the other presumed "links" which are supposed to connect the various groups we will find that some other interpretation is possible. For an example, it is presumed that *Thorius* was regarded as being linked to "*Oedipus*" by the discovery of *Oedipus townsendi*. That this does not obtain is shown by an examination of the forms that constitute the genus *Thorius*, in which we find the following characters held in common: Skull very poorly ossified; maxillary toothless; prevomers in contact anteriorly; frontal processes of premaxilla pass along the prevomerine suture; parietals widely separated by membrane; orbitosphenoids widely separated from parietals and frontals; premaxillary fontanelle re-

† Dunn apparently has the erroneous impression that the species of *Oedipus* are ovoviviparous. *Adpersus* is the only one that to my knowledge has been so described. See Dunn 1926 "Plethodontidae," pp. 47, 48.

duced, a deep orbitolabial groove. *Oedipus townsendi* agrees in none of these characters. It has a series of enlarged dorsal glandules, the maxillary has a large series of pleurodont teeth; frontal processes of the premaxillary do not pass along the common prevomerine suture; skull bony; the parietals forming a common suture; orbitosphenoid in contact with parietal and frontal; a well-developed premaxillary fontanelle; no orbitolabial groove. It differs also in numerous other characters. The species does, however, agree with *Thorius* in that both are small, and have a free tongue and large nostrils. In consequence of these differences it is absurd to regard "*Oedipus*" *townsendi* the connecting link between the genus *Thorius* and "*Oedipus*," or *Thorius* and any other known generic group; or that it would be necessary for it to become extinct in order to recognize *Thorius* as a genus. The differences between *Thorius* and *Oedipina* are likewise equally as significant as those which obtain between *Thorius* and "*Oedipus*" *townsendi*.

Since Dunn does not state the articular variations which are to be found in the genera which he recognized in the plethodontids, one may presume that the data and material available to him were inadequate for him to make use of this character in delineating the genera; nor was he aware, apparently, of other vertebral characters which seem to be invariably present in given genera, and which might serve as additional discriminating characters between genera. Moreover, the presence or absence of a sublingual fold has either been overlooked or has been given no weight; adequate weight has not been given to the foot and hand characters, the differential characteristics of the premaxilla, the relationship of other skull bones, and the presence or absence of the prefrontal bones. The size of the nostril has perhaps been given more importance than it merits, since seemingly the large nostril may develop independently in unrelated genera or within a single genus, and of itself may not show other than ecological relationship.

In the specific treatment, Dunn has confused several species, misidentified some, and incorrectly synonymized others, and not impossibly, his erroneous grouping may be in part due to these errors. I have not as yet examined all the material seen by him. There are possibly other errors of identification than those listed here.

1. *Oedipus belli*.† Confuses *belli*, *gigantea* and *gadovii*. The

† The reference, p. 358, *Geotriton belli* Garman states "p. 471." This is incorrect. The page is 39, and the combination as such is not used. The name *S. belli* appears in a list under a genus, *Geotriton*.

latter is separated in the addenda as a distinct species. The synonymy of *bellii* still includes such references as apply to *gadoni*.

2. *Oedipus sulcatus*. This is not *Spelerpes sulcatum* Brocchi. The figure given by Brocchi shows a diminutive form having the fingers and toes more or less grown together (syndactylous). The specimens Dunn refers to this species are *smithi* (Taylor). I have elsewhere called attention to his error in the description (p. 260) which states "13 costal folds between adpressed toes." His statement, p. 33, "*sulcatus* from western Mexico," is incorrect. The actual type locality is unknown. Specimens which Dunn believed to be this form were from eastern Oaxaca.

3. *Oedipus chiropterus*. Dunn has referred the following numbers to *chiropterus* erroneously: M. C. Z., 3404 = *leprosus*; 8408 = *cephalicus*.

4. *Oedipus townsendi*. Dunn has confused two forms, *townsendi* and *dimidiata*. The specimens listed as cotypes from Hidalgo are of the latter species.

5. *Oedipus pennatulus*. Confuses four species: *Thorius narisovalis*, U. S. N. M., 47608; *T. pulmonaris*, U. S. N. M., 47797; *Thorius pennatulus*; and U. S. N. M., 30348, consisting only of a head, which is not of this species or genus, but a sharp-snouted species, perhaps an *Oedipina*.

6. *Oedipus cephalicus*. Confuses specimens of *Spelerpes leprosus* Cope, *Spelerpes cephalicus* Cope, *Oedipus* sp., *Spelerpes chiroptera*, and *Bolitoglossa nigropunctata* Taylor, with this species.

U. S. N. M., No. 123592, sp. unidentified, is certainly not *cephalica*. U. S. N. M., No. 6340 = *Bolitoglossa nigropunctata*, two specimens. M. C. Z., Nos. 8417, 8418, 8420, 8421, 8423, 8426, 8427, 8431, are *leprosa* (only a part of this series, M. C. Z., 8417-8432, seen). I originally assigned these to *Oedipus orizabensis*. An examination of a large collection from Orizaba shows only a single form, there being some difference in specimens from low and high elevations. I am considering these all as *leprosus*. Nos. 8419, 8424, 8428, 8429, and 8430 are *Pseudoeurycea cephalica*. No. 8432 is *Chiropterotriton chiroptera*.

7. *Oedipus salvini*. Confuses *Oedipus flaviventris* with this form (*vide* Schmidt, 1936).

8. *Oedipus attitlanensis* is a synonym of *Oedipus salvinii* (*vide* Schmidt, 1936).

9. *Oedipus altamazonicus*. Confuses *Spelerpes peruvianus* Boulenger with this form. *Peruvianus* is a distinct form (*vide* Parker, 1939).

10. *Oedipus adspersus*. A. M. N. H., Nos. 13058-9 and A. M. N. H., Nos. 10330-9, referred to *adspersus*, are not of that species.

11. *Oedipus morio*. According to Schmidt, specimens referred by Dunn to this form belong to a different species, *Oedipus dunni* Schmidt.

12. *Oedipus lignicolor*. Refers A. M. N. H., 21370 (yg., 33 mm. in length) to this form. It is an *Oedipina complex* with 17 costal folds.

13. *Oedipus yucatanus*. Confuses *Spelerpes doffleini* with this form; *doffleini* is distinct from *yucatanus*. (Fide Stuart, 1943).

14. *Oedipus platydactylus*. Confuses *Spelerpes mulleri* and *Bolitoglossa mexicana* with this species. These two forms, *mulleri* and *mexicanus*, are distinct. (Fide Schmidt, 1936 and Stuart, 1943).

15. *Oedipus rostratus* Dunn = *Oedipus morio* Cope. (Fide Dunn in Schmidt, 1933).

DISCUSSION OF GENERIC CHARACTERS

Foot and hand. Type I. The typical, primitive, unmodified, terrestrial forms have the digits unwebbed beyond the metatarsals or metacarpals, while certain more specialized ones may have the first phalanges partly or wholly included in the web. The phalanges are more or less hourglass-shaped, elongate, and the terminal ones are more or less widened at the tip. The phalangeal formula is normal and the digits are freely movable individually, while the terminal adhesive pads and the palm and sole are not strongly specialized. This group comprises a number of high mountain forms, and a few that tend to descend the sides of the plateau to lower elevations (in one case, that of *nigropunctata*, to less than four thousand feet). These species occupy territory from Nuevo León, to the central and southern parts of the Mexican plateau, and extend into Central America. Probably the oldest generic group of the family, the various species or species groups display greater differentiation one from another than those in other similar generic groups. Representatives of these generalized forms are *leprosus*, *altamontana*, *bellii*, *smithi*, *gadovii*, *goebeli*, *cochranae*, *galeanae*, *unguentis*, *melanomolge*, *robertsi*, etc.

Type II. In the foot structure of this type, the digits of hand and foot are widespread, the subdigital termination bearing small, discrete, terminal pads which are truncate or, rarely, slightly pointed. The palm and sole are in the nature of a thick smooth pad which includes the proximal phalanges and the entire first toe and finger.

The digits are not, or but moderately, widened. In the young the nostrils are very large, a character which may or may not be retained in the adults. Some of the forms are terrestrial (*dimidiata*, *chiroptera*, *terrestris*, *chondrostega*, *mosaueri*), some arboreal or bromeliicolous (*arborea*, *nasalis*, *lvae*, *xolocalcae*) and at least one both terrestrial and arboreal (*multidentata*), and they are chiefly high

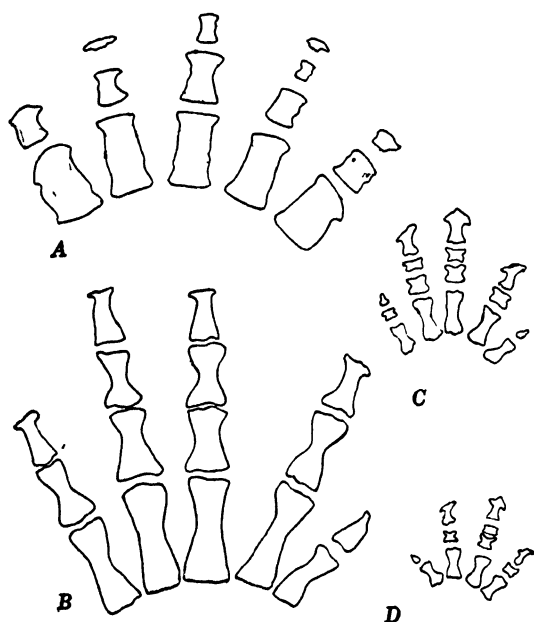


FIG. 1

- A. *Bolitoglossa flaviventris* (Schmidt).
Metatarsals and phalanges of foot. (Foot type III.)
- B. *Pseudoeurycea leprosa* (Cope).
Metatarsals and phalanges of foot. (Foot type I.)
- C. *Thorius narisovalis* Taylor.
Metatarsals and phalanges of foot. (Foot type V.)
- D. *Thorius narisovalis* Taylor.
Metacarpals and phalanges of hand (? Foot type V.)

mountain dwellers. Species having hands and feet of Type II have a distribution from Nuevo León, México, south to Central America over the eastern part of the plateau.

Type III. A third type of foot and hand is present in a group of species which are chiefly Central American in distribution but with one or two representatives in the southern part of México. In this type the toes themselves are much widened and often sharply trun-

cate, the two middle digits being relatively shortened. The sub-terminal digital pads and the thick pad on sole and palm are reminiscent of those described in the preceding group. However, I do not regard the two types as representing close relationship since the groups (general) differ from each other in other fundamental characters, such as the absence of the sublingual fold, and the presence of typical amphicoelous vertebrae in that having the Type III foot. It may be presumed that any similarity between them is due to environmental circumstances which have brought about parallel de-

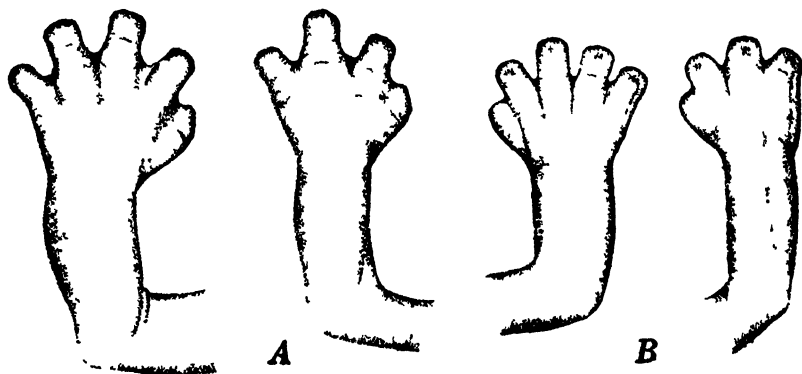


FIG 2

A *Magnadigita dunni* (Schmidt)

Foot and hand (enlarged) Field Mus No 4550, type These represent typical hand and foot forms of *Magnadigita*

B ? *Magnadigita adspersa* (Peters)

Foot and hand Amer Mus Nat Hist No 13061

velopment. However, Types II and III are readily distinguishable, the one from the other, and likewise, from other types here considered. Examples of Type III are *machrinii*, *nigroflavescens*, *flavimembris*, *robusta*, *dunni*, etc.

Type IV. A fourth group has the foot and hand completely or almost completely palmate, leaving only the extreme tips of the digits extending beyond the thick "web." In this group the digits may or may not be capable of independent movement. In undisturbed specimens the "web" is thick and is a continuous part of the pad that covers the sole and palm and includes the digits. In captured specimens when there has been much secretion from these pads, the "web," as such, is more evident. In some of the species, the individual digits are scarcely discernible exteriorly. On dissection certain of the phalanges are found to be shortened and

widened, the widening the result of the growth of a bony web along each side of the hourglass-shaped bone. The bony phalangeal formula may appear reduced since the terminal phalanges may be represented by only a minute cartilage. Members of this group are normally bromeliculus and their presence on the ground is for the most part accidental or temporary. It may be presumed that this type of foot is most efficient in moving over the smooth-leaved bromelias and plantains; and likewise it has permitted the development of the larger arboreal forms. Examples of this group are *platydactyla*, *mexicana*, *flaviventris*, *lignicolor*, *yucatanica*, *salvini*, *rufescens*, etc.

Type V. It is not so easy to explain a fifth modification which involved the fusion of the digits for a part or the whole of their length, the digits themselves not being involved in a palmate pad, but retaining their individuality. Sometimes the types are rounded and partially free, sometimes sharply pointed at their terminations, and fused almost to their tips. With variations, this foot type is present in several small generic groups. The members are terrestrial or fossorial, living under leaves, rocks, or tending to burrow in rotting logs and detritus of various types. Generic examples are *Batrachoseps*, *Oedipina*, *Thorius*, etc.

Accepting the presumed aquatic origin of the plethodontids as fact, it would appear that webbing of the digits did not develop in response to the swimming stimulus, since the tail and not the limbs was the chief primitive organ of locomotion. The feet of salamanders with aquatic habitats usually are but little modified.

On land, however, a number of factors may be involved in changing the character of hand and foot. One might postulate that the winds which are responsible for the distinct wet and dry season are the remote stimulus for the development of the "webbed" foot in many of the salamanders. The winds prevent rain and tend to bring about a lack of surface moisture. This drives the salamanders to occupy, perhaps first, thick clumps of grass, terrestrial bromeliads and bromelia-like plants which can collect water, and then later, as they become still more modified by increase in the adhesive pads, to occupy the arboreal species of the families of water collecting plants.

The terminal phalanges of the unwebbed, relatively narrow-toed forms usually have a slight terminal widening, often described as "T-shaped." This widening may be absent on certain of the toes, the bone assuming the shape of a modified claw. This widening likewise is present in the partly webbed groups.

It would appear that the "webbing" is brought about by an increase in the number of small glands, which push along the digits and between the digits. This "web" provides a greater glandular surface for hand and foot so that the animal is enabled to ascend trees and climb about on smooth-leaved plants which hold moisture or collect it during the dry season. Usually the glandular web is not movable, and the digits of the hand and foot are kept continually widespread, apparently largely incapable of independent movement.

Sublingual fold. The sublingual fold appears in certain genera, and is absent in others. Its presence may have something to do with the ancestral condition, where the tongue is normally attached throughout life. Thus in certain very young specimens of a species, free-tongued in an adult state (removed from the egg), it appears that the tongue is attached. In *Haptoglossa* the tongue remains attached in the adult, as is likewise true of *Batrachoseps*, and the raised line of attachment is seemingly equivalent to the fold of the free-tongued forms. The character of the fold itself differs somewhat in the different genera of both free-tongued forms and those with attached tongues, in which it is present.

In at least a part of the genera having the tongue attached anteriorly (*Batrachoseps*) there is a distinct sublingual fold, and the attachment is along the median part of the fold for a greater or lesser distance. In *Eurycea*, in which the tongue is free, the fold is present in most if not all the species (all not examined). In *Pseudotriton* the membranes of the floor of the mouth are ample but the sublingual fold is scarcely represented in certain forms. The reduction of the membranes of the floor of the mouth and the complete absence of the fold seems especially significant in the genera *Bohtoglossa* (*sensu stricto*), and in *Magnadigita*, a genus herein described.

Intervertebral articulation. The vertebral articulation present in fully developed specimens of the salamanders under discussion fall into three general classes: amphicoelous, intermediate, and opisthocelous. In the amphicoelous type, the intervertebral notochordal material, always present in the embryo, remains as embryonic protocartilage, or is replaced by true cartilage. Usually when the vertebrae are separated, the greater part of the cartilage adheres to the anterior part of a centrum. If the animal is macerated, or is allowed to rot, the cartilage disintegrates completely, leaving two cone-shaped cavities in the ends of the centrum.

In the intermediate class there is some calcium deposited in the

cartilage, and this adheres to the deeper part of the cup, or may fill up the entire cup to the posterior level of the centrum. This is a progressive process, the younger specimens showing less deposit than very old specimens.

In the true opisthocoelous type, the entire intervertebral cartilaginous mass becomes calcified (or ossified) and is attached to the anterior part of a centrum, filling the entire cup of the centrum and also forming the ball, of a ball and socket joint, for articulation with the preceding vertebra. In younger specimens the deposition may not fill the cup and in still younger specimens the material may be cartilage. Thus unless a knowledge of the size and age of a specimen in relation to the normal maximum of the species is known, conclusions based on vertebral articulations are apt to be misleading, as might be true of any animal with an adult bony skeleton, since the young might show much more cartilage. However, if one is able to examine old adult specimens, there is as great a specific and generic constancy in vertebral articulation as obtains in any character.

The use of the vertebral articulations as a basis for discrimination between the families Desmognathidae and Plethodontidae was criticised by Percy Moore* because he had noted that certain salamanders which in early stages may be amphicoelous are strictly opisthocoelous in old age. On the basis of the literature he regarded the character of vertebral articulation as the only significant difference between the families. He therefore decided that the family PLETHODONTIDAE and DESMOGNATHIDAE should be united because "the failure of the only important character which has seemed to make the family distinction of the PLETHODONTIDAE and DESMOGNATHIDAE desirable renders their separate continuance no longer necessary."

Dunn, apparently misled in a measure by the Moore paper, erroneously makes a wide application to any "systematic division." His statement is,† "Moore in 1900 showed that the difference between amphicoelous and opisthocoelous was a matter of individual age, and that systematic divisions based on this character were worthless."

If we agree that species and genera are "systematic divisions," the above statement is not wholly true since Moore's findings do show that certain genera (genera established on other characters) may or do have fixed, old-adult characters as regards vertebral articulation. Thus, he points out the following facts (Moore, p. 618).

* Proc. Acad. Nat. Sci. Philadelphia, 1900, pp. 618-622.

† The Salamanders of the Family Plethodontidae, p. 88.

Hemidactylium always strictly amphicoelous.

Plethodon (four species) amphicoelous.

Autodax (one species) biconcave.

Oedipus variegatus [= *Bolitoglossa platydactyla*] biconcave, but "the anterior cup about one-third filled with calcified cartilage."

Gyrinophilus porphyriticus opisthocelous, the anterior cup filled or with the calcification extending beyond the rim of centrum.

Spelerpes bellii [= *Pseudoeurycea bellii*] amphicoelous, but with a possibility that it may change later in life (as it does not agree with the development in the three forms of *Spelerpes*). [*bellii* actually belongs to a different genus.]

Spelerpes longicaudus [= *Eurycea longicauda*], *Spelerpes bilineatus* [= *Eurycea bislineata*] and *Spelerpes guttolineatus* [= *Eurycea longicauda gutto-lineata*] opisthocelous (the anterior cups filled and with only a slight concavity).

Skeletal characters. Many if not all of the individual species segregated on the basis of the foot characters, presence or absence of the sublingual fold, and the characters of the vertebral articulations, may likewise show other skeletal characters in common which point to generic relationships. Thus in the group having the Type II foot, one may observe that the parasphenoid has a characteristic lateral notch; the orbitosphenoid is narrowed posteriorly, then suddenly widens to its greatest width anterior to the middle, then again becomes gradually narrower anteriorly; the brain case is wider in proportion to length than in certain other groups.

Certain of the generic groups have the dorsal ridge on the vertebrae well developed; in others it is low; while in still others scarcely a trace remains.

In certain of the genera there are no small lateral spines or "wings" on the side of the posterior part of the centrum, while they are present in two of the groups.

One genus *Oedipina* has a broad winglike bony development extending from the transverse processes along the posterior part of the vertebra.

I cannot distinguish any of the groups by the characters of the ribs or the transverse processes, yet some differences are present when individual ribs or individual vertebrae are compared. Contrary to Dunn's statement,† the ribs are, with few exceptions, forked

† Dunn states, "The ribs like those of Salamandridae and Ambystomidae, are forked distally" (p. 44, "The Salamanders of the Plethodontidae"). The ribs of the Salamandridae and Ambystomidae are likewise forked proximally.

proximally and not distally. Only the ribs of the second and third vertebrae may be also forked distally, that is, forked at both ends.

Dental characters. For the most part, the maxillary teeth of the southern plethodontids are pleurodont in character. However, in one genus, having the completely palmate hand and with the sublingual fold entirely missing, the teeth arise from the flat surface of the bone, rather than from along the edge of the maxilla. The teeth are relatively small and weak, reduced in number, and in two forms are apparently completely absent in adults.

With the exception of this group, there is constancy in the presence or absence of the maxillary teeth. In *Thorius* they are invariably absent in the known species, and invariably present in the other generic groups under consideration.

The maxillary teeth are normally in a single row in most of the genera save that in *Batrachoseps* there may be several rows present.

Prevomerine teeth are in one continuous row in most species; however, in younger specimens of certain species, in both young and adults of others, there may be several short rows which give the teeth a grouping often designated as a "patch." This condition appears in certain species of *Batrachoseps*, and is present in *Bolitoglossa yucatanana* and occasional *Bolitoglossa platydactyla*. Some specimens of *Pseudocurycea cephalica* likewise may have the prevomerine teeth in a patch.

The teeth, widely known as "parasphenoid teeth," appear on two bony plates which are loosely attached to the undersurface of the parasphenoid. These plates are generally regarded as backward growths of the prevomers and in some genera remain unseparated from them, as continuous processes of the prevomers. However, in most genera they form two separate bones which bear larger or smaller series of teeth. The name *paravomers* for these separate elements has been suggested to me by Dr. Hobart M. Smith, a suggestion which I shall follow.

These bones are variable in width, sometimes narrow, widely separated, and having several very short diagonal rows of teeth, sometimes much widened, so that the two plates are continuous, bearing several long diagonal rows of teeth, the rows from the two bones tending to meet mesially and together forming a pattern of chevrons. When the specimens are allowed to macerate, these plates separate readily from the parasphenoid, since they are not sutured to the parasphenoid or to each other. The teeth themselves rot away at their bases and are lost, since the tooth base is not solid dentine or dentine and enamel like the remainder of the tooth.

When the paravomerine teeth are described as forming a single "patch," one must know that they are merely the same two groups (normally forming two series) that have become closely approximated.

The width of the paravomers is apparently not a generic character in all cases, as several of the generic groups outlined previously may have these tooth groups separated in some of the larger members and closely approximated in certain of the more diminutive species. In certain other generic groups there is constancy in the character of their close approximation.

The sexual differentiation in the tooth characters is marked, at least in adults. Practically all the species have dental dimorphism which in the males results in larger teeth on maxilla and more especially the premaxilla. In a large number of cases the males have a smaller number of teeth on maxilla, premaxilla, and mandible. The dimorphism is either absent or less obvious as applies to the paravomerine and prevomerine teeth. As has been frequently pointed out, the premaxillary teeth of males often pierce the gums, and are visible even when the lips are closed. Moreover, the actual shape of the teeth, as well as the size, may differ in the two sexes. Some species may have the tooth tips darkened, some blackish, some reddish in color.

GENERIC GROUPS

Of the genera herein discussed, *Bolitoglossa*, *Pseudoeurycea*, *Chiropoterotriton*, *Magnadigita*, *Parvimolge*, and *Oedipina* have the following characters in common: Digits, four anterior, five posterior; teeth invariably present on the paravomers, mandibles and premaxilla; premaxilla single; a fontanelle present between the frontal processes of the premaxilla and frontal; choanae open through a notch in the prevomers, no ossified pterygoids or pterygoid process on the squamosal or quadrate; otic capsule (periotic) never divided into two (or more) bones; occipital condyles sessile; operculum present; no bony septomaxilla. Tongue and hyoid apparatus attached to ventral surface of pelvis by two greatly elongate, narrow muscles; uniform hyoid apparatus; tongue boletoid, free; a nasolabial groove; carpals and tarsals of cartilage; lungs absent; frontal processes of maxilla never suturing or fusing behind fontanelle; atlas with two small spines on centrum, the anterior process ("odontoid process") with two articulating surfaces; eyes normal; no palmar tubercles; a specialized glandular area behind insertions of hind limb in both sexes; sexual dimorphism indicated by papillae in male cloaca, folds

in females; a submental (hedonic) gland in males; subnasal region more inflated in males; females usually larger, the body slightly longer in proportion to length of limbs.

The characters by which the genera vary are: the presence or absence of the prefrontal; character of maxillary teeth; presence or absence of a sublingual fold; character of feet, indicating adaption to terrestrial, subterrestrial, semiarboreal or bromeliad life; degree of ossification and relationship to each other of various bones of the skull; crests, wings or spines on dorsal vertebrae; the character of vertebral articulation (amphicoelous, opisthocoelous, or intermediate).

Too few of the characters of *Haptoglossa* have been given to compare it fully with the above group of genera. The fact that the tongue is not free sets it apart from *Thorius* and the above group of genera.

Thorius differs from the preceding group of genera in the foot characters; presence of an orbitolabial groove; separated parietals; absence of maxillary teeth; median part of brain case membrane; some forms with ossified carpals and tarsals; otic capsule and mandible rather well ossified while many other skull bones remain either cartilage or very weakly ossified; vertebrae opisthocoelous with rounded, anterior, articular condyles; fontanelle between frontal and frontal process of premaxillary, reduced.

Batrachoseps, also entering the Mexican fauna, has multiple tooth series on maxilla, digits 4-4, tongue not free; parietals, widely separated, the median part of brain case membrane; frontal processes of premaxillary fused, or not, the fontanelle reduced or absent; septomaxilla present (*vide* Dunn); no prefrontal; vertebrae preceding the sacral vertebra more than 15.

PSEUDOEURYCEA genus novum

Genotype *Spelerpes leprosus* Cope

Characters. Middle digits of hand and foot free beyond the metatarsals and metacarpals or at most involving the proximal phalanges; vertebral articulation intermediate, the cavity of the anterior part of centrum may be filled to the posterior surface of centrum, but lacking any trace of a rounded, terminal condyle; teeth on maxilla, premaxilla and mandible, pleurodont; premaxilla single, the frontal processes arising from a slight elevation on premaxilla; a well-defined fronto-premaxillary fontanelle; columella absent from the operculum; parasphenoid lacking a lateral notch; no septomaxilla; no lateral spines or "wings" on the posterior parts of centra (save atlas); a sublingual fold present.

Referred species. The species referred to this genus fall into several groups which are of almost generic character. These are:

GADOVII GROUP

- Pseudoeurycea gadovii* (Dunn)
- Pseudoeurycea unguidentis* (Taylor)
- Pseudoeurycea melanomolge* (Taylor)

SMITHI GROUP

- Pseudoeurycea smithi* (Taylor)

CEPHALICA GROUP

- Pseudoeurycea galeanae* (Taylor)
- Pseudoeurycea cephalica cephalica* (Cope)
- Pseudoeurycea cephalica manni* (Taylor)
- Pseudoeurycea cephalica rubrimembris* (Taylor & Smith)

BELLI GROUP

- Pseudoeurycea bellii* (Gray)
- Pseudoeurycea gigantea* (Taylor)

LEPROSA GROUP

- Pseudoeurycea altamontana* (Taylor)
- Pseudoeurycea cochranae* (Taylor)
- Pseudoeurycea robertsi* (Taylor)
- Pseudoeurycea leprosa* (Cope)
- Pseudoeurycea nigromaculata* (Taylor)
- Pseudoeurycea goebeli* (Schmidt)
- Pseudoeurycea rex* (Dunn)
- ?*Pseudoeurycea barbouri* (Schmidt)

The range of this genus extends from Zacatecas and Nuevo León

PLATE XII

- FIG. 1. *Pseudoeurycea gadovi* (Dunn). Hand and foot. EHT-HMS, No. 17176, topotype; Orizaba Volcano, 11,000 ft.
- FIG. 2. *Pseudoeurycea robertsi* (Taylor). EHT-HMS, No. 12503, type; Nevada de Toluca, México.
- FIG. 3. *Pseudoeurycea smithi* (Taylor). Hand and foot. EHT-HMS, No. 3966, type; Cerro San Luis N. W. Oaxaca, Oaxaca.
- FIG. 4. *Pseudoeurycea altamontana* (Taylor). Hand and foot. EHT-HMS, No. 12245, type; Lake Zempoala, Morelos.
- FIG. 5. *Pseudoeurycea cephalica cephalica* (Cope). Hand and foot. EHT-HMS, No. 12098, Lake Zempoala, Morelos.
- FIG. 6. *Pseudoeurycea leprosa* (Cope). Hand and foot. EHT-HMS, No. 12215, near Río Frío, México.
- FIG. 7. *Pseudoeurycea gigantea* (Taylor). Hand and foot. MCZ, No. 8437, type; Jalapa, Veracruz.
- FIG. 8. *Pseudoeurycea goebeli* (Schmidt). Hand and foot. EHT-HMS, No. 29879, paratype; Volcan Tajumulco, Guatemala.

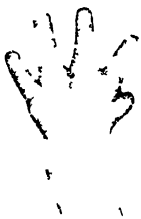
PLATE XII



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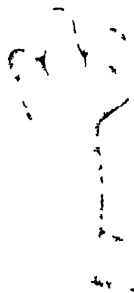
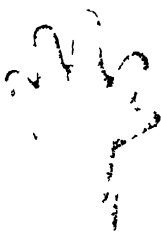
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south on the Mexican Plateau, two forms, *rex* and *goebeli*, occurring in Guatemala. Only one species, *Pseudoeurycea bellii*, is known to occur in the Sierra Madre del Sur in Guerrero, where it is the only known salamander.

The genus *Pseudoeurycea* has undergone its greatest development in the plateau region of México, practically no part of which lacks a representative (with the possible exception of the most north-western part). At least five subgeneric groups are present, and usually only one species of any given group occurs in a given locality. Thus in the general region on and about Mt. Orizaba one species belonging to each of four groups occur: *Pseudoeurycea gadovii*, *cephalica cephalica*, *gigantea* and *leprosa*. On Mt. Popocatepetl three groups, represented by four species, *bellii*, *cephalica cephalica*, *leprosa* and *altamontana* occur. On Cerro San Felipe, Oaxaca, *bellii*, *unquidentis*, *smithi* and *cochranae* are found—four species representing four groups. On Nevado de Toluca, in western México (state), *robertsi*, *bellii* and *cephalica cephalica* occur—three species and three groups.

Thus in only one case (Mt. Popocatepetl) do we find two species of one group represented—that *leprosa* and *altamontana*. The two forms also occur together in the Ajusco range (Lagunas de Zempoala).

On the periphery of the range, in the north only *cephalica galeanae* has been found; to the west in Jalisco, Zacatecas, and south in Guerrero only *bellii*; in lower elevations in the east (Veracruz) only *nigromaculata* is known to occur.

When the internal anatomy of the *leprosa* group is better known, the differences between *altamontana* and *leprosa* may be found to be greater than they now seem to be. In Guatemala it has not been shown that *rex* and *goebeli* occur together.

Oedipus barbouri Schmidt is referred to this genus with a question. The toes are free. Whether the sublingual fold is present has not been ascertained.

CHIROPTEROTRITON genus novum

Genotype *Oedipus multidentata* Taylor

Characters. Small mountain salamanders adapted to both terrestrial and arboreal life. Hand and foot widespread, the proximal phalanx of each digit included in the fleshy web; under surface of digit tips with discrete, rounding, elevated pads, thickest posteriorly; first finger and first toe almost completely included in web; the last finger and toe well developed; palm and sole a glandular pad which is smooth, not showing the metatarsals and metacarpals. Tongue free with a membranous semicircular sublingual fold below anterior part of tongue (or somewhat anterior to it). Young with much enlarged nostrils, retained in certain adult forms. Teeth typically pleurodont on maxillary, premaxillary and mandible; paravomerine tooth patches either separate or closely approximated and forming a single patch; mandible usually not strongly ossified; carpals and tarsals of cartilage; metatarsals, metacarpals and phalanges well ossified; phalanges hourglass-shaped; terminal phalanges with a narrow or a wider, T-shaped termination.

The following characters are also common to most if not all the species. The premaxilla is single and is usually well ossified, narrow, bearing from seven to nine teeth; the frontal processes arise separately and pass up and back, separated from the skin by a thin mass of glands; the processes are attached to the nasals and frontals, and border a fontanelle lying partly between the anterior ends of the frontals and the processes; maxillaries and mandibles always toothed. Prevomers separated anteriorly, sutured only posteriorly, usually at about the level of the posterior edge of the choanal opening, touching the edge of premaxilla narrowly, widely separated from frontal or premaxillary processes. Paravomerine teeth on parasphenoid in two groups, narrowed somewhat anteriorly, and close together, wider and more separated posteriorly. Orbitosphenoid widest medially, narrowing at both ends, bordered above by the frontal and parietal, ventrally by the parasphenoid; optic foramen large, usually its diameter equal to half the posterior width. Frontals and parietals forming median sutures. Otic capsules (periotic) well

PLATE XIII

- FIG. 1. *Chiropterotriton bromeliacea* (Schmidt). Hand and foot. EHT-HMS, No. 27090, paratype; Volcan Tajumulco, Guatemala.
- FIG. 2. *Chiropterotriton chiroptera* (Cope). Hand and foot. EHT-HMS. No. 4475; km. 67, México-Puebla Highway, México.
- FIG. 3. *Chiropterotriton laeae* (Taylor). Hand and foot. EHT-HMS, No. 28937, type; 2 mi. W. La Joya, Veracruz.
- FIG. 4. *Chiropterotriton arborea* (Taylor). Hand and foot. EHT-HMS, No. 16734, type; near Tianguistengo, Hidalgo.
- FIG. 5. *Chiropterotriton nasalis* (Dunn). Hand and foot. EHT-HMS, No. 27286, paratype; mountains above San Pedro, Honduras.
- FIG. 6. *Chiropterotriton multidentata* (Taylor). Hand and foot. MCZ, No. 14812, paratype; Alvarez, San Luis Potosí (8,000 ft.).
- FIG. 7. *Chiropterotriton xolocae* (Taylor). Hand and foot. EHT-HMS, No. 25331, paratype; Cerro Ovando, Chiapas.

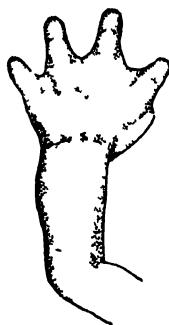
PLATE XIII



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ossified, lacking crests or spines but with three low, elongate, dorsal ridges, forming a triangular dorsal depression; lachrymal foramen between prefrontal, maxillary and nasal; operculum a flat plate, from the edge of which arises a short columella. Fifteen vertebrae precede the sacral vertebrae; no dorsal crests present and no spines on centra save on sides of atlas; atlas not modified.

Referred species. Besides the genotype, *Chiropterotriton multidentata* (Taylor), the following species are referred to the genus:

<i>Chiropterotriton chiroptera</i> (Cope)	<i>Chiropterotriton terrestris</i> (Taylor)
<i>Chiropterotriton dimidiata</i> (Taylor)	<i>Chiropterotriton larvae</i> (Taylor)
<i>Chiropterotriton chondrostega</i> (Taylor)	<i>Chiropterotriton zolocalcae</i> (Taylor)
<i>Chiropterotriton mosaueri</i> (Woodall)	<i>Chiropterotriton nasalis</i> (Dunn)
<i>Chiropterotriton arborea</i> (Taylor)	<i>Chiropterotriton bromeliacea</i> (Schmidt)

Remarks. The terrestrial types are *chiroptera*, *dimidiata*, *chondrostega*, *terrestris*, *mosaueri* and *multidentata*. The first mentioned form, *chiroptera*, is found most frequently under pine and other logs or in the crevices of rotting wood, under rocks, clumps of grass and piles of leaves. I have never taken the species in either terrestrial or arboreal bromelias. However, there are usually no, or but few bromelias in the regions, and at the elevations, where the species is most numerous. The species has been taken most frequently at from 9,000 to 12,000 feet elevation. In the region of the Lagunas de Zempoala, and elsewhere in the Ajusco range in eastern México and western Puebla (Mt. Tlaloc, Ixtaccihuatl and Popocatepetl) and east in the region of Cofre de Perote, Veracruz, this species is very numerous.

During the dry season this form finds shelter deep among rock piles, in the roots of rotting stumps and sometimes in the thick basal masses of the mountain grass clumps, which remain moist during much of the dry season. My first visits to the northern slopes of Cofre de Perote were made in June at which time the specimens were extremely numerous at Cruz Blanca. The place was visited later in the season on two or three occasions and not a single specimen could be found where literally thousands might have been collected earlier.

Chondrostega resembles *chiroptera* in most details but the skull is largely cartilaginous, the bones are extremely fragile (especially the vertebrae and limb bones), and the atlas is shortened. The foot shape is almost identical with that of *chiroptera*, and its habitat is likewise similar. The species has been found only in the general region about the type locality. None have been taken in bromelias—in fact no bromelias were observed in this immediate region.

Mosaueri occurs in this same locality but I suspect that this species is subterrestrial, living in the cavities in limestone rocks, which are

abundant in this region. The types were found in the mouth of a small cavern some feet below the ground.

Arborea and *terrestris*, two other members of the genus, occur in central northern Hidalgo and may actually be present in suitable localities in the same region where *chondrostega* and *mosaueri* occur. In the mountain region in southern Hidalgo two other forms, *multidentata* and *dimidiata*, occur, the latter known only from this range, the other, *multidentata*, occurring as far north as San Luis Potosí. I have seen an undescribed species of this genus that was taken on Cerro Potosí near Galeana, Nuevo León.

Chiropterotriton lavae is known only from bromelias on the plateau edge in central western Veracruz, but I suspect it is likewise to be found in the lava rocks which occur in such abundance in the region. To the south a species, *xolocalcae*, has been recently discovered on Mt. Ovando, southern Chiapas. It is so far known only from the bromelias of this region. Still farther southeast *nasalis* occurs. This latter form apparently is also largely or entirely bromelia-inhabiting. It combines the character of small fingers and toes (similar to *chiroptera*) with a very large nostril.

Multidentata, occurring in the mountains of Hidalgo and San Luis Potosí, is a form that is both terrestrial and arboreal, and is apparently the most generalized form. During the wet season the greater number of specimens were to be taken on the ground, while a few only were to be found in bromelias. The elevation at which the species occurred most frequently was 9,000 to 11,000 feet. It differs from *chiroptera* in the retention of all or most of the maxillary teeth in the males (all but a few enlarged teeth are lost in *chiroptera* males), longer tail, longer limbs and a slightly wider skull. Proportionally the digital tips are very slightly wider than in *chiroptera*.

Arborea, *chiroptera* and *lavae* have a small number of enlarged teeth on the maxillaries of the males. The sublingual fold under the tongue (or slightly in advance of it) is always present. It may represent a line of lingual attachment in its ancestors. It is not to be confused with the membrane attaching the ceratobranchial heads, immediately anterior to the base of the tongue.

The evolution of this generic group has taken place largely in México. *Multidentata* appears to be a more generalized form and I suspect this or a related form may be ancestral to the group. The other species all may be regarded as more specialized. This specialization is largely evidenced by reduction in size, variation in dental characteristics (chiefly the size, shape and number of teeth). While

there is a variation in length of limb with relation to body length and size of foot, the general *shape* of the foot, its pads and its wide-spread character remain unchanged. The slight increase in the length of limb and width of the toes in *arborea* is an adaptation to a more complete bromeliad habitat. The paravomerine tooth groups are close together in *dimidiata*, *terrestris* and *chondrostega*, which may be a result of the small size of these forms.

When the Central American countries south of Guatemala are better explored herpetologically, it seems likely that the genus will be traced farther to the south than it is now known.

MAGNADIGITA genus novum

Genotype *Bolitoglossa nigroflavescens* Taylor

Characters. Digits wide, more or less truncate, the outer one or two phalanges greatly shortened and free. No sublingual fold; metatarsals, metacarpals and phalanges poorly ossified; prefrontals present, premaxilla single, the spines arising separately; vertebrae completely amphicoelous, the centra large, thin walled, with a lateral keel or wing on the side; maxilla toothed; tongue free; no septo-maxillae; occipital condyles sessile; carpals and tarsals cartilage; atlas with narrow winglike shelf along centrum instead of the two lateral spines, not obviously specialized; phalanges compressed, flattened, with some evidence of a lateral bony web. Usually (if not invariably) oviparous.

The foot pattern is held with rather rigid tenacity throughout the range, only that of *Magnadigita flavimembris* showing a slight departure from the typical (see Pl. XIV, fig. 8).

Referred species: Aside from the genotype *Magnadigita nigroflavescens* (Taylor), the following species are associated with this genus: *Magnadigita macrinii* (Lafrentz); *Magnadigita lincolni* (Stuart); *Magnadigita englehardti* (Schmidt); *Magnadigita rostrata* (Schmidt); *Magnadigita robusta* (Cope); *Magnadigita franklini* (Schmidt); *Magnadigita flavimembris* (Schmidt); *Magnadigita dunni* Schmidt; *Magnadigita cuchumatana* Stuart; ? *Magnadigita morio*; ? *Magnadigita adspersa* (Peters); ? *Magnadigita subpalmata* Boulenger. The three last species are referred here tentatively.

The Mexican species of this genus are confined to the southern part of the country, *Magnadigita macrinii* being known only from a range of mountains in southern Oaxaca, and *Magnadigita nigroflavescens* from Mt. Ovando in southwestern Chiapas. Other species range south through Central America and into South America.

BOLITOGLOSSA Duméril and Bibron

GENOTYPE *Bolitoglossa mexicana* Duméril and Bibron

Characters. Digits 4-5; feet and hands palmate, none or only tips of digits free; no sublingual fold; prefrontal present; premaxilla single, the spines arising separately; a fronto-premaxillary fontanelle; teeth on maxilla (normally) but these not typically pleurodont, but arising from flat surface of bone, and not at the edge (two forms lack teeth). Tongue free, but no trace of a sublingual fold; vertebrae completely amphicoelous; no bony septomaxillae; occipital condyles sessile; carpals and tarsals cartilage; metatarsals, metacarpals, and phalanges compressed, hourglass-shaped with lateral bony webs; phalangeal bony formula may be reduced (some of the terminal phalanges represented by cartilage only); oviparous; no aquatic stage; costal grooves 13, costal folds 12; 15 vertebrae precede the sacral vertebra; spines on sides of posterior part of centra; atlas not obviously specialized; paravomerine tooth patches on the parasphenoid closely approximated.

The species of the genus have greatly enlarged nasal capsules which extend in both sexes out over the upper lip. The premaxilla is single, reduced, weakly ossified, the base lying almost horizontal, the frontal processes pushing up between the nasal capsules near their posterior part; the nasal bones are relatively very large, generally triangular in shape, and may touch each other above the premaxillae. At least certain forms (*flaviventris*) have only eight carpals. The prefrontals are greatly reduced, but usually if not always form a part of the border of the lachrymal foramen; the choanae open through a notch in the prevomer.

Referred Species. Species are referred to the genus, as follows:

<i>Bolitoglossa colonneae</i> (Dunn)	<i>Bolitoglossa salinus</i> (Günz)
<i>Bolitoglossa occidentalis</i> Taylor	<i>Bolitoglossa flaviventris</i> (Schmidt)
<i>Bolitoglossa helmerichii</i> (Schmidt)	<i>Bolitoglossa lignicolor</i> (Peters)
<i>Bolitoglossa rufescens</i> (Cope)	<i>Bolitoglossa yucatanica</i> (Peters)
<i>Bolitoglossa doffleini</i> (Werner)	<i>Bolitoglossa mexicana</i> Duméril and Bibron
<i>Bolitoglossa mulleri</i> (Brocchi)	<i>Bolitoglossa odonnelli</i> (Stuart)
<i>Bolitoglossa platydactyla</i> (Cuvier)	<i>Bolitoglossa borburata</i> Tapido

The following species are tentatively referred to the genus:

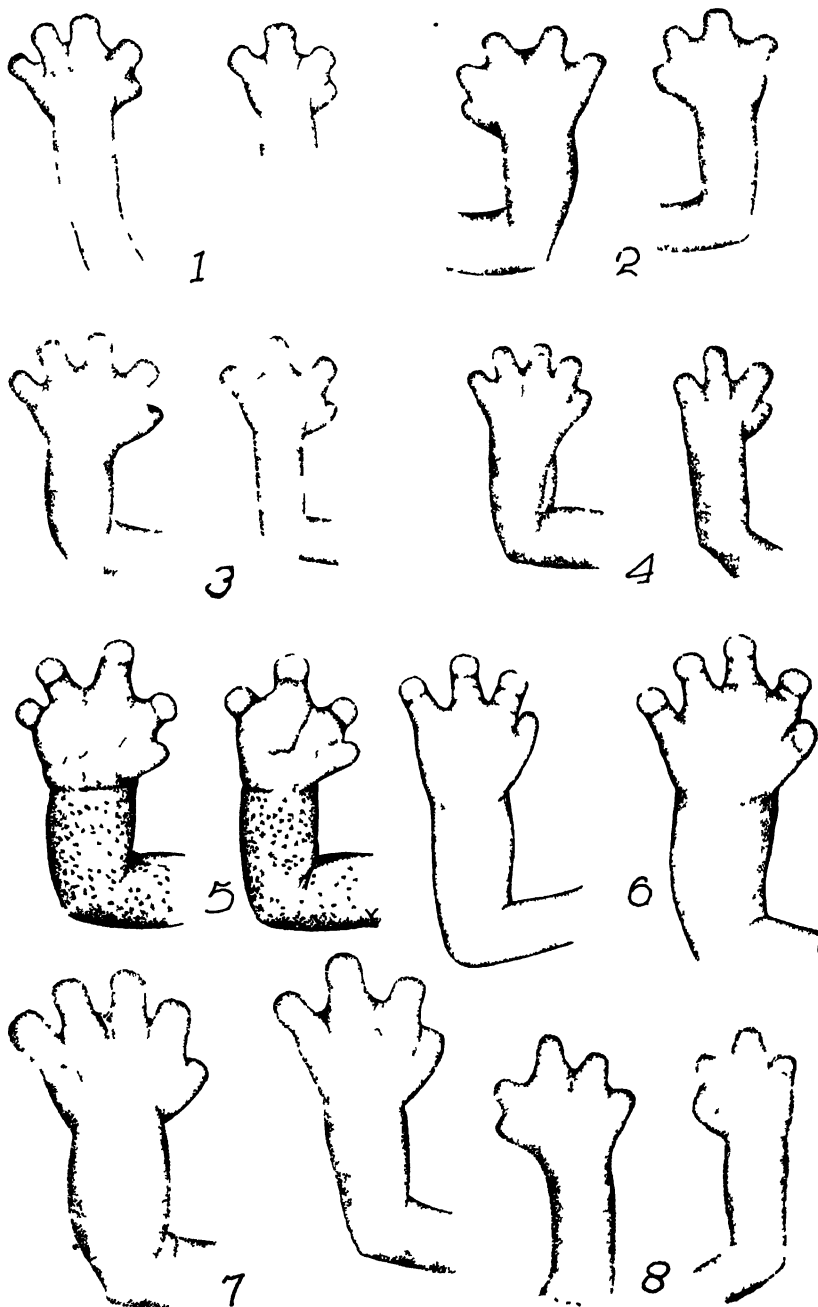
<i>Bolitoglossa schmidti</i> (Dunn)	<i>Bolitoglossa ahlí</i> (Unterstein)
<i>Bolitoglossa altamazonica</i> (Cope)	<i>Bolitoglossa paraensis</i> (Unterstein)
<i>Bolitoglossa peruviana</i> (Boulenger)	<i>Bolitoglossa striatula</i> (Noble)

Save for Noble's (1921) figure of "*Oedipus adpersus*" and his statements regarding the same, the skeletal anatomy of this second group of species is unknown to me. Noble's figure shows that the prefrontal bone is absent in *adpersus*. He states: "Very marked differences in the anterior cranial elements distinguish *adpersus* and

PLATE XIV

- FIG. 1. ? *Magnadigita macrinii* (Lafrentz). Hand and foot. AMNH, No. 6240; San Pedro Alta, Oaxaca.
- FIG. 2. *Magnadigita englehardti* (Schmidt). Hand and foot. EHT-HMS, No. 27276; Volcan Atitlan, Guatemala.
- FIG. 3. *Magnadigita rostrata* (Schmidt). Hand and foot. EHT-HMS, No. 27285; above Tecpan, Guatemala.
- FIG. 4. *Magnadigita robusta* (Cope). Hand and foot. USNM, No. 37773, La Palma, Costa Rica.
- FIG. 5. *Magnadigita nigroflavescens* (Taylor). Hand and foot. EHT-HMS, No. 27263; Cerro Ovando, Chiapas.
- FIG. 6. *Magnadigita lincolni* (Stuart). Hand and foot. UMMVZ, No. 89109; Monte at Salquil Grande, El Quiché, Guatemala.
- FIG. 7. *Magnadigita franklini* (Schmidt). Hand and foot. EHT-HMS, No. 27274; Volcan Atitlan, Guatemala.
- FIG. 8. *Magnadigita flavimembris* (Schmidt). Hand and foot. EHT-HMS, No. 27272, Volcan Tajumulco, Guatemala.

PLATE XIV



striatulus from *leprosus*. *Oedipus variegatus*, the type of the genus, is so closely allied to *O. striatulus* that it seems probable that these cranial patterns will be shown to be the same. The following characters common to *O. striatulus* and *O. adpersus* may be considered the distinguishing features of the *Oedipus* as now defined [by Noble]: "(1) no prefrontal; (2) no septomaxilla; (3) premaxillae ankylosed only at their extreme anterior ends."

From this one is led to believe that the prefrontal bone is absent also in *striatulus* and *variegatus* [= *B. platydactyla*] Cuvier. However, the prefrontal actually is present in the two latter species. I have not examined the former.

If Noble is correct in the identification of the specimen which he figured as *Oedipus adpersus*, there is very considerable doubt that the species belongs to any of the genera here defined.

The genus will doubtless eventually be divided into two or more subgenera. The most obvious division is between the larger, long tailed species, represented by *platydactyla*, and small short-tailed forms represented by *rufescens*.

The range of *Bolitoglossa* is along the eastern lowlands of México (to 3,500 ft. elevation) from eastern San Luis Potosí south through Central America and into South America.

Representatives of two groups of the genus occur in México.

Platydactylus has been traced to the north along the eastern lowlands as far as San Luis Potosí. East and south of the isthmus *mexicana*, *flaviventris* and *yucatan* occur. Two Mexican forms belonging to the group of smaller species are known. *Rufescens*, a toothed species, has a range similar to *platydactyla*. In the Pacific drainage south of the isthmus it is replaced by a closely related, toothless, species, *occidentalis*.

Representatives of the genus have been traced to the mouth of the Amazon in Brazil. The extent of the range of the genus in South America depends upon the final disposition of species tentatively referred to it.

The validity of the genus *Eladinia* Miranda-Ribeiro is in question. It was erected for a species described from embryos and newly hatched young, from the Utinga forest, Pará, Brazil, which he believed was different from other South American species in being oviparous. Parker (1939) believes that it may be the young of *Oedipus altamazonicus*. However it would be extremely difficult to draw a generic distinction on very young specimens. Neither Parker nor Miranda-Ribeiro have considered the possibility of a relationship with Unterstein's lowland forest species, *Oedipus paraensis* from Santa Isabel near the city of Pará (Belem), Brazil.

PARVIMOLGE genus novum

Genotype *Oedipus townsendi* Dunn

Characters. Diminutive salamanders, characterized by a series of much enlarged dorsal glandules arranged irregularly on each side of the median dorsal line. Skull well ossified; pleurodont teeth on maxillae; paravomerine teeth on parasphenoid in a single patch (2 very closely approximate series); frontal processes of premaxilla arising separately, very close together, not fused or sutured posteriorly; prefrontal absent; carpals and tarsals cartilaginous; phalanges normal; anterior part of centra cylindrical, acelous, but lacking rounded anterior condyles; no orbitolabial groove; fingers and toes fleshy, syndactylous, with the tips of the three middle toes and the outer fingers free and pointed rather than rounded; a sublingual fold present. (For foot type see pl. XV, fig. 2.)

Skeletal characters of Parvimolge townsendi (Dunn). The prevomers are closely approximated medially but not sutured, save posteriorly; the premaxilla bears seven teeth; the frontal processes, arising from an elevation on the upper part of the base premaxilla, very closely approximated and continuing close together to the frontals and enclosing a narrow fontanelle; frontals and parietals form a straight median suture. Otic capsule well ossified; the orbitosphenoid sutured to the parietal and frontal, the optic foramen large; mandible largely cartilage with one small and four or five very large teeth (at least in the male), extending above the level of the jaw a distance equal to the height of jaw itself. Vertebrae, 15 anterior to the sacrum; atlas not strongly modified, except that the body of the vertebrae is only a little longer than the "odontoid" articulating process. Body vertebrae lacking dorsal crests or spines; no lateral wings behind the transverse processes.

Referred species. Only the genotype, *Parvimolge townsendi* (Dunn).

Remarks. This species lives in the same general region where *Thorius pennatululus* Cope occurs and is of about the same size. It may be readily distinguished from members of that genus, by the absence of the orbitolabial groove, the greater degree of cranial ossification, the enlarged dorsal glandules, the presence of the maxillary teeth, frontal processes of premaxillary not in contact with the prevomerine suture, prevomers forming a continuous suture, and the presence of cartilaginous carpals and tarsals.

Specimens from Guerrero, Hidalgo, which Dunn associated with *P. townsendi* as paratypes, belong in a different genus. These are

PLATE XV

- FIG. 1. ? *Oedipina complex* (Dunn). Hand and foot AMNH, No. 40473; Barro Colorado I., Panamá
- FIG. 2. *Parvimolge townsendi* (Dunn). Hand and foot EHT-HMS, No. 26562, paratype; Jalapa, Veracruz.
- FIG. 3. *Bolitoglossus* ? sp. Hand and foot. AMNH, No. 10339; Bogotá, Columbia.
- FIG. 4. *Bolitoglossa occidentalis* Taylor. Hand and foot. EHT-HMS, No. 24049, paratype; Finca Juárez, Chiapas, México.
- FIG. 5. *Bolitoglossa mexicana* (Gray). Hand and foot. AMNH, No. 45339; Cofradia, Honduras.
- FIG. 6. *Bolitoglossa helmrichi* (Schmidt). Hand and foot. EHT-HMS, No. 27053; near Samac, west of Coban, Guatemala.
- FIG. 7. *Bolitoglossa flaviventris* (Schmidt). Hand and foot. EHT-HMS, No. 3995; Tonalá, Chiapas.
- FIG. 8. *Bolitoglossa platydactyla* (Cuvier). Hand and foot. EHT-HMS, No. 15202, near Córdoba, Veracruz.

PLATE XV



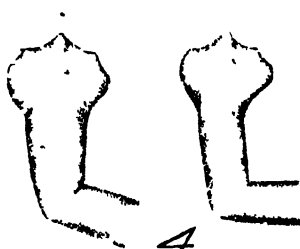
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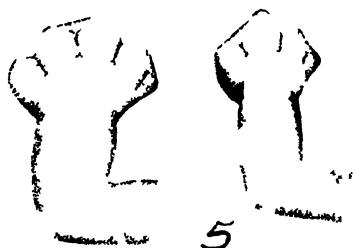
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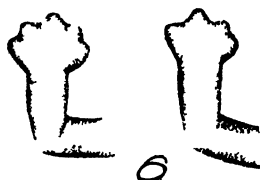
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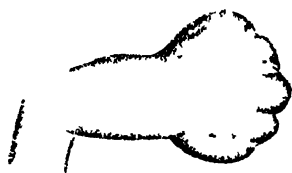
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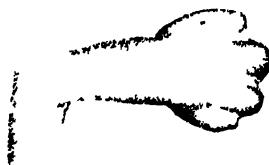
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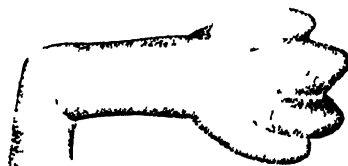
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Chiropterotriton dimidiata Taylor. This form may be readily distinguished by hand and foot form, the presence of a prefrontal, no enlarged dorsal glandules on the back, etc., etc. Both have enlarged nostrils.

OEDIPINA KEFERSTEIN

Genotype *Oedipina uniformis* Keferstein

Characters. Elongate, slender-bodied terrestrial salamanders, the tail longer (usually very much longer) than head and body; digits largely or entirely syndactylous, the tips more or less pointed; a sublingual fold; 16 or more vertebrae preceding the sacral vertebrae, all with broad elongate alar expansions on the sides behind the transverse processes; no dorsal crests on body vertebrae, and no lateral spines on ventral or lateral part of centra.

Premaxilla somewhat ossified, rather narrow, rectangular; the frontal processes arising from a common elongate stem, and separated only narrowly; teeth on maxilla pleurodont; a prominent maxillary shelf; paravomerine tooth groups juxtaposed, appearing as a single patch; no orbitolabial groove.

Characters of Oedipina lineola Cope. Maxilla ossified, the teeth pleurodont, increasing in size toward premaxilla; premaxilla with two enlarged teeth in males, $1\frac{1}{2}$ times as wide as high; orbitosphenoid forming sutures with parietal and frontal, widening a little in the middle; optic foramen relatively very small, about one-fifth the width of the bone on a level with the foramen; the paravomerine tooth series on the parasphenoid are very closely approximated, appearing as a single group; frontals and parietals ossified, forming a straight, median suture; carpals and tarsals cartilage; a fontanelle present.

The feet and hands have the basal part of the digits grown together but the two middle fingers and three middle toes are free for some distance; the toes are bluntly pointed. In the adult the tail is twice the length of head and body.

Referred forms. The following species are referred to this genus: *Oedipina uniformis* Keferstein, *Oedipina lineola* (Cope), *Oedipina complex* (Dunn), *Oedipina elongata* (Schmidt), *Oedipina parvipes* (Peters), *Oedipina collaris* (Stejneger), *Oedipina alfaroi* (Dunn). See comment below.

Remarks. There is some doubt whether all the elongate wormlike forms of Central and South America are congeneric with *uniformis* and *lineola*. The skeletal characters of most of the group are unknown and there is a probability that an examination of the skele-

tons will prove that more than a single genus is represented. The more obvious external and dental differences of the seven forms are here shown. Grouped according to the presence or absence of maxillary teeth they may be separated as follows:

Maxillary teeth		No maxillary teeth
<i>uniformis</i>	<i>elongata</i>	<i>alfaroi</i>
<i>lineola</i>	<i>parvipes</i>	.
<i>complex</i>	<i>collaris</i>	

When grouped according to snout shape the groups are as follows:

Blunt snout	Sharp snout
<i>uniformis</i>	<i>parvipes</i>
<i>lineola</i>	<i>collaris</i>
<i>complex</i>	<i>alfaroi</i>
<i>elongata</i>	

The absence of teeth may not be a generic character, but with few exceptions in amphibians, teeth are present in a given genus, or invariably absent in another. One exception to this in the plethodontids is recognized in the genus *Bolitoglossa*: *Bolitoglossa rufescens* is without, *Bolitoglossa occidentalis*, with maxillary teeth; *Bolitoglossa colonnea* is without maxillary teeth while the related *Bolitoglossa striatula* has them. An examination of the external and skeletal characters of the first pair of species show them to be very closely related.

The foot character of a specimen from Barro Colorado Island, identified as *Oedipina parvipes*, is different from *lineola* in that the digits are more entirely grown together; the toes are flattened and only the middle toe and the two middle fingers have the tips free; the digits for the most part terminate in sharp points.

This specimen has 17 costal grooves, the hind legs reaching about the length of four and one half costal folds, the arm, four folds, the digital tips being separated by six and one-half folds.

As now known, the genus *Oedipina* extends from central Veracruz south through Central America into northern South America.

Only *Oedipina lineola* is known to occur certainly in México; and as far as collections go it seems to be confined to the low mountain slopes in western central Veracruz. The specimens collected have been found chiefly in piles of chips, and under trash on the ground in the coffee and banana plantations.

The placing by Dunn of *Spelerpes (Oedipus) infuscatus* Peters (having 14 costal grooves, and purporting to come from Haiti) as a questioned synonym of *lineolus* may be warranted since *lineola* is

known to have 14 costal grooves and 13 costal folds. However, comparing the description of *infuscatus* with a specimen of *lineola* of the same size, (21 mm. snout-to-vent) the following differences obtain: Head width (2.48 mm.) in snout-to-end-of-vent length (21.2 mm.) 8.5 times, instead of 7 times. The arm reaches about half the distance between arm insertion and the corner of the mouth, instead of "almost to the corner of mouth;" the hind leg reaches forward beyond the middle of the 11th costal fold. Specimens of *lineola* of this size have the nostril still large, a character not noted in the description of *infuscatus*. The original description is very brief, and other differences may actually obtain. That *Spelerpes infuscatus* is a synonym of *Oedipina lineola* is not established beyond a doubt.

THORIUS COPE

Genotype *Thorius pennatululus* Cope

Characters. Very diminutive salamanders; tongue free with a sublingual fold present; a deep orbitolabial groove, running from eye diagonally back to lip; digit fused together at bases, the middle digits somewhat widened and rounded, and free at tips. Skull poorly ossified, the parietals not forming a median suture, separated by a membrane; orbitosphenoid widely separated by membrane from parietal and frontal; maxilla edentulous; mandibular and prevomerine teeth present; operculum with a minute columella fused to it; premaxilla single, very small, triangular, bearing from 1-3 teeth in males, the frontal processes arising from the base, separately, then apparently suturing, or at least continuing side by side to dorsal surface of skull where they again separate; processes in contact with prevomers along their mutual suture, thus completely separating the nasal capsules by bone; orbitosphenoid nearly rectangular, the optic foramen occupying one third of its width; paravomerine teeth on the parasphenoid in two closely approximated groups (appearing as a single-heart-shaped group); lower jaw well ossified; atlas greatly shortened, the "odontoid" articular process nearly as long as remainder of vertebrae; vertebrae completely opisthocoelous, the anterior part of centrum with a rounded condyle, lacking wings posterior to the transverse processes; 15 vertebrae precede the sacral vertebra; nostril large, varying from very large to moderately large in various species, carpals and tarsals ossified; none or but a small anterior fontanelle between frontal processes of the premaxillae.

Referred species. In addition to the genotype, *Thorius pennatululus*

Cope, the following four: *Thorius dubitus* Taylor, *Thorius troglodytes* Taylor, *Thorius narisovalis* Taylor, and *Thorius pulmonaris* Taylor.

Remarks. These diminutive salamanders are terrestrial. None have been found above the ground save that *Thorius narisovalis* occurs under the bark of fallen trees. Some of the species have the habit of coiling in a flat spiral. The presence of strongly ossified carpals and tarsals, and the deep groove from eye to mouth, separate these from all other genera in Mexico having a nasolabial groove. Apparently there are eight tarsals present. The five species known have a limited distribution in central western Veracruz, and in Oaxaca. A sixth and undescribed species occurring in northeastern Puebla has the nostril reduced in size. *Pennatulus*, occurring between three and four thousand feet elevation, is the smallest species; *Thorius narisovalis*, the largest species, occurs at still higher elevations, some up to 10,000 feet. I suspect that the genus has a much wider distribution than is known at present.

The skull shown by Cope, pl. XXXVII, Bull. 34, U. S. Nat. Mus., purporting to be *Thorius pennatulus*, is not the skull of any of the species of *Thorius* which I have examined. I strongly suspect that some error is involved. The presence of teeth on the maxilla, the much enlarged vomerine teeth, the absence of spines on the premaxilla, the suture of the frontal with the orbitosphenoid, all point to some other species, belonging to another genus.

The figure given by Boulenger (Catalogue of the Batrachia Gracientia s. Caudata and Batrachia Apoda in the collection of the British Museum, 2d Ed., 1882, p. 79, pl. III, fig. 2), is a species of some Mexican salamander which probably does not belong in this genus. The head is thick and there is no orbitolabial groove shown. The "dark lateral band white margined above," also suggests a species that is not a *Thorius*. It is very difficult to say what species is intended.

HAPTOGLOSSA Cope

GENOTYPE *Haptoglossa pressicauda* Cope

Characters. "Tongue adherent in front and by the middle; digits not distinct, four anterior, five posterior; vertebrae opisthocoelous; carpus and tarsus not* ossified."

Remarks. Dunn has synonymized *Haptoglossa pressicauda* with

* Cope may have intended to write "not cartilage" instead of not ossified, since the genus *Thorius* of his family THORIIDAE (THORINAE) with which he compares it has ossified carpals and tarsals.

Oedipus uniformis with the following comment. "Cope's *Haptoglossa pressicauda* is probably the present form. The type has been destroyed. The proportions, dentition, color, and indeed everything except "the tongue adherent in front and by the middle are so like those of young *uniformis* that I cannot help thinking they are the same. I include it in the synonymy with a query."

Cope in his description states that "This genus is of much interest as the first one discovered in Tropical America in which the tongue is not boletoid in form," and points out that "It seems also that the relation of this form of the western coast to those of the east coast of this group is the same in Costa Rica as that which prevails in North America. It is well known that no species of salamander, with a boletoid tongue, is found on the Pacific coast of North America." Since Cope has used the character of the attached tongue for the above comment, it seems very unlikely that his statement "tongue adherent" is a lapsus or due to faulty observation.

The species is a short tailed form, "Length of tail equals that of body without the head. Tail compressed from near base to apex, with a median dorsal but no ventral groove, and well-marked vertical grooves." Cope also points out that the species resembles *Thorius* and *Oedipina*, but that it differs from these latter in the shorter, compressed tail, as well as in the generic characters listed.

Since no species of *Oedipina* (or of "*Oedipus*") is known to have the tongue adherent, I believe Dunn's action in placing this form in synonymy, even with a question mark, wholly unwarranted. That the species has not been rediscovered is not surprising, since diminutive forms are very secretive, and special effort is necessary to find them.

SPECIES INCERTAE SEDIS

Two species, referred by Dunn (1926) to his genus *Oedipus*, *Spelerpes picadoi* Stejneger, and *Spelerpes sulcatum* Broochi, have not been referred to any of the genera defined here. Specimens of the former which I have been able to examine are in such a state that I cannot be certain of their affinity.

To the best of my knowledge no specimens of *Spelerpes sulcatum* save the type series are in collections. The final disposition of this species must await an examination of the type, and a study of the internal anatomy of the species.

NOTE.—Part II of this paper (to be published later in this journal consists of a comparative anatomical study of species of the various genera delineated here.

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JUNE 15, 1945

[No. 13

List of Publications from the Science Departments from January 1, 1943, to June 30, 1944

Compiled by HOMER B. LATIMER

THE University of Kansas Science Bulletin has published many papers and yet these papers are but a very small part of the total number of research papers published from the science departments. It was the feeling of the Science Bulletin Committee that a complete listing of all research papers from the various departments would be desirable, and in accordance with the instructions of the Committee, the following list of papers has been prepared. A circular letter was sent to all science departments asking for titles and references and we hope that we have listed correctly all papers which should have been given in this list.

BEAMER, R. H. 1943. Some new species of *Typhlocyba* (Homoptera, Cicadellidae). *Canadian Entomologist*, 75, 132-133.

BEAMER, R. H. 1943. Notes and descriptions of some species of *Dikraneura* (Homoptera, Cicadellidae). *J. Kan. Ent. Soc.*, 16, 54-63.

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The Environment, Life History and Structure of the Water Boatman, *Ramphocorixa acuminata* (Uhler) (Hemiptera, Corixidae)*

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ABSTRACT: *Ramphocorixa acuminata* (Uhler) is particularly successful and widely distributed in the prairie pond environment of middle-western, south-western, and Mexican plains. The one companion species in the genus, *R. rotundocephala* Hungerford, is found in México and the Greater Antilles. The habit of laying eggs upon crayfish has long provoked interest and debate; protection from drought and enemies, aëration, and convenience are factors discussed in connection with the curious preference shown in oviposition. The life cycle phenomena—eclosion, growth, exuviation, self-maintenance, mating, oviposition—are described from the field and laboratory, with notes on the diet, associates, pests and predators of the water boatman. The work closes with an illustrated discussion of the skeletal structure and its homologies.

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PREFACE

THE objectives of this experimental essay on the life and structure of our most interesting species of water boatman are those of any introductory study—to inform and to stimulate. It is hoped accordingly that the deficiencies in the first objective may bring the compensation of an added impetus toward the second. The success of an introduction depends measurably upon the future acceptance of the challenge in the problems suggested or imperfectly solved. Though an extension of this work is intended, the conclusion must be written in the critical appraisal of other students, to whom I heartily commend the profitable exercise in appreciative thought which any species successfully meeting the problems of its environment must deservedly arouse.

May others enjoy as generous assistance and kindly indulgence as has been granted me. I wish to express sincere appreciation for the facilities provided, the time and thought expended, and the forbearance shown by all members of the University of Kansas Department of Entomology—Doctors P. B. Lawson, K. C. Doering, R. H. Beamer, L. C. Woodruff, and particularly Dr. H. B. Hungerford, whose ever-helpful enthusiasm was an unfailing inspiration and encouragement. Dr. H. H. Lane, Dr. W. J. Baumgartner, and others of the Department of Zoölogy, assisted with suggestions and special apparatus. The Harris crayfish collection was resurrected for me by Mr. C. D. Bunker. The University of Michigan Biological Station made available the opportunity for collection and study of valuable morphological material. Dr. Philip Levereault gave many helpful suggestions upon fundamental morphological interpretations and the preparation of the plates. Dr. A. D. Whedon provided facilities and suggestions for making the microscopic slides recently of much service in checking conclusions of the gross dissections. Mr. Robert Guntert demonstrated the possibilities of aerated aquaria in rearing aquatic Hemiptera, and gave ready assistance on many occasions. Dr. Robert Polson cheerfully aided on field trips in all seasons. The University of Minnesota Library has been most courteous in lending periodicals recently, and my wife, Pauline Bogart Griffith, has loyally assisted in preparing photostat abstracts. With these co-workers and all other contributors, I wish to share the best in this work, reserving the responsibility for its errors.

PART I—ENVIRONMENT, HISTORY AND DISTRIBUTION

"Whatever ideas the different branches of biological science may accumulate the ultimate object is to discover how the different entities of the biological world are related with one another."—Maulik (1939).

THE PASTURE POND

CONDITIONS

In Kansas there are several thousand pasture ponds, more than one hundred in Douglas county. These numbers are typical of similar areas in the Middle West. Some of the ponds are natural pools—the wallows, water holes, sinks and oxbows of the prairie. Others are impounded waters in shallow, scooped-out basins and intermittent stream beds, retained by indifferent embankments or permanent dams, and fed by ground waters or the watershed. These ponds are usually ovate, narrower toward the source, and rarely more than several hundred feet in circumference or five feet in depth. They are constantly menaced by erosion and evaporation, though persistent marginal trampling by livestock often discourages the encroachment of plants.

The short history and irregular fluctuations of the average western pond are not conducive to satisfactory generalizations. Wide variations in water level, turbidity and temperature are reflected in light penetration, photosynthesis, decomposition and other factors conditioning the dissolved gas content and the productivity. For example, one small, muddy stock pond in Douglas county, evaporating at high surface temperatures (104° F.) and filled with dying and decaying organisms, cleared perfectly two weeks later (Aug. 14, 1941) following rains, with renewing population, abundant algal growth, and oxygen near saturation (at 88° F.).

The water is often crowded with organic material and the bottom covered with fine debris, easily disturbed and slow to settle. Absence of wind action and currents may be followed by surprising temperature and chemical stratification. Slight alkalinity seems the rule in all seasons, though pH 6.6 to pH 8.2 has been recorded in Douglas county ponds. This agrees with the results of Eddy (1934) in Illinois. The general physical, chemical and ecological aspects of pond environments have been discussed by Shelford (1911, 1937), Chapman (1931), Welch (1935) and Pearse (1939), with excellent bibliographies.

SEASONS AND BIOTIC REQUIREMENTS

The pasture pond is an essentially isolated and characteristic environment of the western plains, receptive to particular species and communal life—though haphazard disturbances by livestock, unpredictable seasonal misfortunes, and other factors of variability and impermanence may affect representative ponds. Those in this region are often the vernal-autumnal type. The wakening abundance of spring is followed by the hard restrictions of summer drought. The turmoil of struggle for preservation is cramped and desperate as the water subsides to barren mud. Revival comes with autumn rains, but these are followed by the ordeal of winter freezes.

Individually and racially, all pasture pond organisms must pass certain entrance requirements for admission to select standing in this difficult regime. Emphasis falls on adaptability (cf. Shelford's "flexible mores," 1911), energy and endurance. Each organism must fit into the conditions, find the requisite foodstuffs, withstand the rigors of climatic extremes, respond quickly in brief, favorable periods, and defend itself effectively. Each species must be prolific, the life cycle fitted snugly with seasonal changes and the available facilities for reproduction and growth. Jewell (1927) suggested short life and semiaquatic habit, or resistance to extreme conditions, if permanently aquatic, as chief characteristics of prairie pond animals. Chapman (1931) stressed the high biotic potential of the pond fauna.

Even temporary ponds usually teem with life. Mozley (1932), in his study of such a pond in Western Canada, suggested that alternation of moist and dry conditions has an important part in the high productivity. A functional, if imperfect, state of balance is an immediate requirement. Plants must be available to herbivores—the latter in quantities sufficient both to themselves and to the predators. A thoroughgoing account of pasture pond inhabitants is impracticable here, but some representative forms and their interrelationships may be considered.

THE POND COMMUNITY

Vegetation. Stock ponds are rarely encouraged to fulfill their possibilities as water gardens, though nature sometimes manages it without assistance. Usually conditions and appearances remain fitting the purpose of the water hole or wallow. Some few ponds are shaded by trees, and support the tall stems of bur reed, sweet flag and cattail. Pondweed, water plantain, arrowhead, water lily and

duckweed may also occur. The larger vegetation is not typical; the shallow plains ponds are too often remote from other waterbodies, easily subject to seasonal disaster, and puddled by livestock which mutilate and destroy the growing plants. Thus obvious and important advantages may be lost in food, shelter, variety, dissolved gas balance, and productive debris.

Vertebrates. Killdeer and other shore birds patrol the pond margins in search of insects. Border plants, infrequently present, attract nesting redwing blackbirds and others. Doves and martins are frequent visitors near habitations; in distant or sheltered ponds, ducks and herons are seen occasionally. Near wooded areas, the soft shore mud may bear testimony to visits of opossum and raccoon, perhaps interested in the frogs, often numerous. Snapping turtles are occasional residents, painted turtles less common. Catfish, perch and minnows are sometimes introduced, but rarely fare well; improper food supply, confinement and impure water are usual disadvantages. Jewell (1927) includes the penitentiary minnow in the characteristic original prairie pond fauna. Tiger salamander larvae are sometimes surprisingly abundant in North Dakota permanent ponds and lakes. Vertebrates are the more spectacular members of the carnivorous pond fauna, wherever they occur, but in real significance are limited to instances of unusual abundance.

Microscopic Life. Algae and Protozoa form that essential subcommunity which basically supports much of the larger pond association. In mats and scums, masses on the bottom, or staining the whole water-body, these minute plants and animals may reach prodigious accumulations in warm, evaporating ponds. The usual condition is more than enough to supply the pond floor grazers (p. 250) fed upon by the predators.

The algae are particularly varied and numerous. The gold and crystal diatoms form spindles and wedges (*Navicula*, *Pinnularia*, *Gomphonema*, *Surirella*), sometimes asymmetrical (*Cymbella*), sinuous (*Pleurosigma*), arranged in wheels (*Asterionella*, *Meridion*) and chains (*Tabellaria*, *Fragilaria*). The blue-greens are present as platelike and spherical colonies (*Merismopedia*, *Coelosphaerium*, *Oscillatoria*), and beaded strings, free or colonial (*Anabaena*, *Rivularia*). The chlorophyll-green algae are represented by lobular and spindle-form desmids (*Cosmarium*, *Netrium*), filaments (*Zygnema*, *Spirogyra*, *Mougeotia*), flagellates (*Chlamydomonas*, *Pleodorina*), and colonies of spores (*Sphaerocystis*, *Tetraspora*), crescents (*Selenastrum*), regular plates (*Scenedesmus*) and scum-forming nets

(*Hydrodictyon*). The variety and interest of the pond algae, added to their importance as food manufacturers and reservoirs, make these humble plants an attractive subject for expansion (Thompson, 1938).

The Protozoa, though usually less numerous and essential than the algae, are more actively individual and with many absorbing similarities to higher animals in problems and reactions. Slow-flowing amoeboids—naked (*Amoeba*) or with shells (*Arcella*, *Difflugia*)—are not as evident or challenging as the scurrying flagellates and ciliates. Individuals of the latter largely retain the basic compressed ovate or cylindrical shapes (*Euglena*, *Phacus*, *Anisonema*, *Notosolenus*, *Trichoda*, *Paramoecium*); notable variations among the infusoria are barrel-like (*Coleps*), long-necked (*Trachelophyllum*), trumpet-shaped (*Stentor*), and bushy forms (*Cyclidium*, *Stylonychia*). Flagellate colonies are commonly free-swimming, in clusters (*Gonium*) and scalloped plates (*Peridinium*). Stalked ciliate individuals (*Vorticella*) and branching colonies (*Zoethamnium*, *Opercularia*) are often attached on plants, molluscs, crayfish, insects and turtles.

In addition to the microscopic plants and animals, bacteria—helped on by the high mortality in pasture ponds and the usual uncleanness—swarm in the waters and bottom debris. In the productive pond community, these three large groups of miniscule organisms—algae, protozoa, bacteria—are interoperative in the all-important spheres of food manufacture, energy storage, decomposition, and the maintenance of dynamic reserves.

Invertebrates. Most animal phyla are represented, when the pond conditions meet their requirements. Fresh-water sponges, hydras and bryozoans are occasional in clearer ponds. Flat-worms and round-worms, rotifers, oligochaetes (*Tubifex*) and leeches (*Placobdella*) are generally plentiful. None surpasses the Crustacea in numbers and constancy; swarms of cladocerans (*Daphnia*, *Bosmina*), copepods (*Cyclops*), phyllopods (*Eubrachippus*, *Apus*, *Estheria*) and ostracods (*Cypris*) occur frequently in freshened waters. Jewell (1927) reported these groups in large numbers in spring and fall, but practically absent in midsummer, and found phyllopods most characteristic in prairie ponds. Mozley (1932) also mentioned the fairy shrimp (*Eubrachippus*), pointing out (cf. Shelford, 1919) that the eggs must be dried and frozen before hatching. Crustacean “nauplius” stages are found in the plankton. Isopods (*Asellus*) and crayfish (*Cambarus*) are numerous. The latter

seem often the most actively voracious members of the larger pond fauna. Snails (*Planorbis*, *Physa*) and clams (*Anodonta*, *Pisidium*, *Sphaerium*) are regularly present, increasing with pond permanency and plant growth. Water-mites are common, the young often attached to insects.

That last ubiquitous group of invertebrates, the Insecta, is well-suited by the usual winged condition and singular hardness to its position of importance in pasture ponds. Some insects are incidental—the inveterate beach-combers of every water body. Butterflies, bees, potter-wasps, and tiger beetles are hurried visitors, with swarms of midges and other flies. Ground beetles (*Bembidium*), shore bugs (*Salidula*) and springtails (*Isotoma*) course over the shore. Mud-loving beetles (*Heterocerus*) and mole crickets (*Grylotalpa*) occasionally burrow in untrampled marginal areas. The true, resident aquatic insects are not necessarily peculiar to the pasture pond, but must show—individuals and species—the qualities for entry, maintenance and rehabilitation required by that environment (p. 245).

Surface Insects. In fresh ponds with plant growth, knobby and globose Collembola (*Podura*, *Bourletiella*) often pepper the marginal surface with tiny bodies. The springtails seem attracted by floating plant fragments, perhaps feeding on the adherent microscopic life. They are known to submerge and are thought to hibernate on the bottom, rising with the first hint of spring. Though fragile in appearance, the springtails display hardness and agility equal to weather changes and probable surface raiders.

Whirligig beetles (Gyrinidae: *Dineutes*, *Gyrinus*) circle dizzily on ponds of all conditions, usually in large schools preying on insects fallen on the surface and scattering or diving when threatened. The gyrenid larvae—pale recluses on the bottom—are rarely seen. They are provided with lateral abdominal gills, and apical abdominal hooks draw them backward. Though predacious, they will accept vegetable material. Fully developed larvae ascend plants and construct pulpy cocoons. The adults appear in late summer; many die in the fall, but others overwinter in the mud banks, easily drawn out by warm weather. Gyrinidae are adept fliers, widely distributed in most fresh waters.

Water striders (Gerridae: *Gerris*, *Rheumatobates*), though awkward off the water, reach many ponds. The gerrids often skate swiftly in large groups, in search of emerging midges, fallen leaf-hoppers, and like prey. The life cycle is passed on the water surface,

where frisking nymphs hatch from the eggs laid on floating grasses and other supports. In the winter, the adults find shelter in the mud banks; the problem of summer drought is more difficult. Survival and increase are likelier on permanent ponds.

Pond Predators. Free-roving, predacious pond insects are best exemplified by the diving beetles (Dytiscidae). These generally range in number and frequency in inverse proportion to their size; the smaller species (*Laccophilus*, *Hydroporus*) are more often numerous than the medium-sized (*Coptotomus*, *Colymbetes*, *Acilius*, *Thermonectes*, *Eretes*), and the larger (*Dytiscus*, *Cybister*) are few. This seems fortunate with respect to their voracious appetites. Molluscs, dragonfly naiads, other insects, and even small tadpoles are representative prey—drained through the grooved mandibles of the beetles. The fierce larvae are appropriately called water-tigers; some (*Coptotomus*) are provided with tracheal gills, but others must secure air at the surface through anal tubes.

Water scavenger beetles (Hydrophilidae) are in part predacious, similar to the preceding family in habit and distribution, though some species (*Berosus*) are vegetarian. The larvae of these remain submerged, having lateral gill filaments, and feed on the algae. The larger carnivorous species (*Hydrophilus*) are not uncommon, while the medium-sized shiny black forms (*Tropisternus*) are among the most typical pasture pond residents. The larvae must ascend to breathe, often dragging other insects aloft to be eaten while the abdomen is thrust out for air. Water scavengers and diving beetles share the advantages of strong flying ability and abundant food supply in the pond environment.

Backswimmer bugs (Notonectidae: *Notonecta*, *Buenoa*) are the familiar, accomplished assassins of the ponds, with stiletto beaks and multitudes of victims. The nymphs feed on the entomostracans, turning in maturity to insects and tadpoles. The smaller species (*Buenoa*) are often incredibly numerous, constantly dimpling the water in rising for air or surface prey. Migrations may attain the magnitude of "showers." Another predacious bug family (Belostomatidae) is remarkable for the oviposition habit. The males of *Belostoma* carry the eggs on their backs, glued there by insistent females. These bugs are usually in ponds with vegetation, though well distributed by flight.

Some few characteristic predacious insects have aerial adults and aquatic larvae, with obvious advantages in pasture ponds. Glistening representatives of the Odonata—dragon flies (Anisoptera) and

damsel flies (Zygoptera)—course to and fro, hunting small flying insects. In spring, mating couples are in flight. The naiads (*Anax*, *Platthemis*, *Tramea*, *Archilestes*) are particularly important in ponds with vegetation, feeding on entomostracans, insects and snails, seized with the curious extensible labium. In turn, they provide other predators with food. The damselfly naiads respire with apical abdominal gill appendages; rectal tracheal gills serve the dragon flies. The latter may inflict painful wounds with spines ringing the anus. The larger naiads of both suborders hibernate in the bottom mud. True flies (Diptera) merit attention here. Horseflies (Tabanidae) are familiar as pernicious blood-suckers; the larvae are also voracious, feeding in the pond mud on insects and snails. The eggs are laid in shining clutches, deposited shingle-fashion on convenient water plants. Phantom larvae (Culicidae: *Corethra*, or *Chaoborus*) prey upon rotifers and entomostracans, seized with the raptorial antennae. They produce mosquitoes which are not blood-suckers.

Pond Grazers. The burden of communal maintenance falls on the herbivores, which must multiply sufficiently for racial security while supplying the predators with food enough to keep them from self-destruction. The pond grazers tap the immense vital reserves in plant life, the algae particularly—and sometimes the intermingled animalcules—and convert them into their tissues which may be used by the carnivores. In this final group, certain insects are representative.

Mayflies (Ephemera) perform their familiar, fleeting dance above the ponds, especially those with vegetation. The naiads (*Caenis*, *Siphonurus*) feed on desmids and diatoms, with occasional tissue fragments from larger plants. They are often abundant and favorite articles in the predatory diet. True flies (Diptera) in this group include the swarms of midges (Chironomidae) and mosquitoes (Culicidae). The bloodworms (*Chironomus*)—well-known as good fish food—are hatched from eggs massed in jelly columns. They feed on algae and decaying vegetation on the bottom, and are found in nearly every water body. The pupae are active, as are the pupae of the blood-sucking mosquitoes (usually *Culex*). The larvae of the latter feed on the microscopic bottom organisms.* Crawling water beetles (Haliplidae: *Haliplus*, *Peltodytes*) are small and hard-shelled. Both the adults and the inconspicuous larvae feed largely on filamentous algae. The herbivorous water scavengers (*Berosus*) have been mentioned (p. 249).

* *Aedes* and *Psephenus* are also common, and the surface-feeding *Anopheles* (including the malaria mosquito, *A. quadrimaculatus*) may become abundant in ponds with vegetation and floating debris.

There remains the important group of pond insects which includes the subject of this work—the water boatmen (Hemiptera, Corixidae). These vigorous bugs are the streamlined counterparts of the backswimmers (Notonectidae) in fitness for their habitat and liveliness, reflected in their awesome numbers, wide distribution and fabulous migrations. They are opposed to their predatory relatives in food habits, feeding on a benthic “salad” of algae, protozoans and rotifers, perhaps including entomostracans and tiny insect larvae. In turn, the water boatmen are relished by predacious insects, fish, birds and other enemies.

Spring and fall are high points in the yearly cycle, when nymphs and adults enjoy the opportunities of well-filled, revived ponds. Representative collections in this region regularly contain many corixids, large and small, with orange-brown bodies and orange-gray-brown pronotum and wings, marked with wavy, transverse lines and splotches (*Corisella*, *Arctocorixa*, *Trichocorixa*). Among these are varying numbers, often dominant, of small, lighter specimens with less distinct wing markings, and with the male head acuminate. These individuals are members of our species, *Ramphocorixa acuminata* (Uhler), which lays its eggs on crayfish (Pl. XVI), and thus provoked the attention leading to an introduction to its life and structure as an interesting native of the prairie ponds. It is hoped that it will be found not only in some measure representative of its own kind, but also indicative of the specialization in form and habit of an animal meeting the requirements of a limited environment.

HISTORICAL SYNOPSIS (1876-1940)

The known record of *Ramphocorixa acuminata* (Uhler) rests in the literature of sixty-five years and fifteen authors. It is summarized in this section as the groundwork for the study, and as an entertaining example in the accumulative composition of the written history of an organism, stemming from an interesting practice in its way of life. The several abstracts follow in chronological order; the articles starred (*) are especially recommended for study in connection with this Introduction. Complete references are starred in the bibliography (p. 329).

1876. *Forbes, List of Illinois Crustacea*: pages 4 and 5.—Corixid eggs were found numerous on *Cambarus immunis* (commonest species of crayfish in central Illinois, especially frequent in muddy prairie ponds) taken from stagnant ponds in midsummer. *Corixa alternata* was suggested as the commoner of two species found in the

ponds, the other being undescribed (Uhler). Preference was noted for the marginal abdomen, with extension along the sides of the cephalothorax sometimes covering the dorsum. Eggs were found only on the crayfish, thought to rescue them from drying ponds by their migratory habits.

*1878. *Forbes, Breeding Habits of Corixa*: page 820.—Corixid eggs were found on *Cambarus immunis*, *C. acutus*, and pond mollusc shells in Illinois. This was considered a provision of nature to guard against the waste of eggs in drying ponds. (See p. 263.)

1897. *Uhler, Contributions towards a Knowledge of the Hemiptera-Heteroptera of N. America*: pages 392 and 393.—*Corixa acuminata*, n. sp. "Pale smoke-brown, narrow, head much longer than the pronotum in the male, produced anteriorly into an acute point, which forms the apex of a thick carina. . . ." Related to *C. Burmeisterii* Fieber. Central Texas, Northern Illinois.

1904. *Crevecoeur, Additions to the List of the Hemipterous Fauna of Kansas*: page 234.—*Corisa scutellata* in stock pond. March, October. (See Bueno, 1920.)

*1912. *Abbott. A new Type of Corixidae (Raphocorixa balanodis n. gen. et sp.) with an Account of Its Life History*: pages 113-121.—Corixids were reared from eggs on crayfish, taken from a small clear-water pond near Columbia, Missouri, in the early part of July. Rearing was unsuccessful in small aquaria, but was completed in an aerated, zinc-lined tank, with soft mud bottom and a few water weeds. Hatching began July 8, with molts approximately July 16, July 24, July 31-August 3, and August 10, the adults appearing about August 18. Detailed descriptions were given the egg and the nymphal instars. The adults were described as a new genus and species with particular emphasis on the cleft palae† and acuminate head of the male, the minute strigil, the short lenticular pronotum, and the frontal fovea of the female. General notes on color: "Head yellowish, tegmina pale silvery grayish, almost iridescent in the female, darker in the male, the characteristic vermiculate or banded markings usual in the group nearly obsolete. Pronotum grayish or smoky brown, suffused with darker in the male. Rostrum pale yellowish. Tergum, legs and whole ventral surface of female pure white. Dorsum of male black, except the lateral margins, which are pale, the ventral surface white, except for two broad almost black oblong bands on either side. . . ." Length, 5 to 5½ mm. Fig-

† "Lower edge (of pala) entire, slightly concave; upper surface flat, deeply incised about midway the length, so as almost to cut the pala into two joints."

ures of the egg, nymphal and adult structures. Columbia, Boone county and St. Louis county, Missouri. July and November.

* 1912. Abbott, *An unusual Symbiotic Relation between a Water Bug and a Crayfish*: pages 553-556.—Corixid eggs were found on *Cambarus immunis*. It was suggested that distribution of the corixid might be conditioned by the association with the crayfish; that the eggs, with adherent debris, might camouflage the crayfish, while receiving protection from egg predators. (See p. 263.) Photograph of dorsal and lateral views of a crayfish bearing several thousand eggs. Columbia, Missouri; Central Illinois; Texas.

1916. Bueno, *Aquatic Hemiptera. A Study in the Relation of Structure to Environment*: 362.—Reference to *Rhaphocorixa*† *acuminata* feeding on an ostracod, as observed by Abbott, 1912. (Abbott suggested the probable synonymy of his species with Uhler's *Corixa acuminata* in a letter to Bueno, subsequent to the description. Though not definitely published until 1920, the synonymy was accepted in this article and in those by Hungerford, 1917 et seq.)

1917. Van Duzee, *Catalogue of the Hemiptera of America North of Mexico*: pages 478, 479.—1419. *Rhaphocorixa balanodis* Abbott. . . . 1421. *Arctocorixa acuminata* (Uhl.).

1917. Hungerford, *Food Habits of Corixidae*: page 2.—Reference to Abbott's observations of the larger nymphs of *Rhaphocorixa* feeding on ostracods.

1917. Hungerford, *Life History of a Boatman*: pages 112-115.—Reference to Abbott's rearing experiments in the introduction to this study of an *Arctocorixa* species. Eggs of *Rhaphocorixa acuminata* were found on crayfish, tin cans and boards, and shells of living snails.

*1919. Hungerford, *The Biology and Ecology of Aquatic and Semiaquatic Hemiptera*: pages 211, 212, 215-221, 246-248.—The genus *Rhaphocorixa* was defined, with notes on the papers by Abbott, the synonymy of *Rhaphocorixa balanodis* and *Arctocorixa acuminata*, and the remarkable sexual dimorphism. The species was described as typically present in muddy, stagnant ponds, probably hibernating there as adults. Eggs were found occasionally attached to sticks and floating plants. The egg positions on the crayfish were tabulated, and discernible preference found for the regions most affected by the currents from the gill chambers. It was suggested

† This spelling of the generic name occurs in several articles, evidently considered the more proper transliteration from the Greek. However, the original orthography was *Rhaphocorixa*. (See Article 19, International Rules of Zoological Nomenclature.)

that these ovipositing sites insured aëration. (See p. 263.) Eggs (on fragments of a crayfish carapace) were placed in a balanced aquarium and adults secured, some being maintained for four months, feeding on the bottom deposits. Figures of areas on the crayfish preferred in oviposition, the egg, and adult structural features. Kansas; Middle West.

1920. Bueno, *On Rhamphocorixa balanodis* Abbott: page 88.—*Rhamphocorixa acuminata* (Uhler), 1897 (*Corixa*) = *R. balanodis* Abbott, 1912. Washington, D. C.; Plano, Texas; Normal, Illinois (U. S. N. M., coll. C. V. R., labeled *Corixa scutellata*).

1922. McAtee, *A Shower of Corixidae (Heter.)*: page 88.—A note by the collector, Mrs. A. P. Bigelow, Ogden, Utah, described the descent of a swarm of the water bugs (*Ramphocorixa* and *Corixa*, det. McAtee), August 2, 1921, 9:00 p. m. They were exhausted and dying, and lay in heaps on the ground through the night and the following morning. Light had not attracted them, and there was no unusual wind when they arrived; the frayed appearance of the water boatmen indicated possible encounter with strong winds before arrival.

*1923. Hungerford, *Notes on the Eggs of Corixidae*: page 13.—Note was made of the selective deposition of the corixid eggs on crayfish for the aëriative benefits of gill currents. Figures of the egg and a crayfish, indicating the preferred areas for oviposition.

1924. Comstock, *An Introduction to Entomology*: page 362.—*Ramphocorixa acuminata* usually attaches its eggs to crayfish. (Repeated through nine editions to 1940.)

1926. Wellhouse, *How Insects Live*: page 98.—Mention of the curious habit of a corixid attaching its eggs to the sides of crayfish.

*1926. Blatchley, *Heteroptera or True Bugs of Eastern North America*: pages 1065, 1067, 1068.—Full descriptive notes were given for the genus and *Ramphocorixa acuminata*. Eggs on crayfish in June and July. Figures of male pala and the heads of the male and female. Eastland county, Texas.

*1927. Hungerford, *A new Ramphocorixa from Haiti*: No. 278.—*Ramphocorixa rotundocephala*. Described from a male, Manville, Haiti, Feb. 6-10, 1922, F. E. Watson (Holotype, Amer. Mus. Nat. Hist.), and two specimens from Cuba. "General color pattern . . . like that of many males of *Ramphocorixa acuminata* (Uhler) that show striping. The dark stripes are more densely pigmented. . . . The head of the male is rounded as viewed from above, not keeled

as ¹¹¹ *Ramphocorixa acuminata* (Uhler). . . ." Figures of pala and genital capsule.

1928. Jaczewski, *Bemerkungen über die geographische Verbreitung der Corixiden*: pages 50, 55, 58, 59, 64.—*Ramphocorixa* was placed among genera of advanced specialization in the Corixinae, probably endemic in the Nearctic Region, though its two species are found in the Nearctic and Sonoran Faunas, from Montana to Haiti and Cuba.

1930. Morgan, *Field Book of Ponds and Streams*: page 226.—The egg-laying habit of *Ramphocorixa acuminata* was compared with that of *Belostoma*. Notes on the work of Abbott and Hungerford. Eastern Kansas.

*1931. Jaczewski, *Studies on Mexican Corixidae*: pages 189, 194-196, 225-227.—Specimens of *Ramphocorixa acuminata* were collected in two Mexican localities on the Pacific slope. The egg collections, taken on *Cambarellus* more than one month later (August) than previously reported in the United States, were considered possibly indicative of more than one yearly generation in Mexico. Additions were made to the descriptive knowledge of the species, particularly the proportions of various structures. The wide area of distribution was stressed. It was suggested that *Ramphocorixa* was originally Sonoran, spreading subsequently eastwards, toward the Atlantic coast of North America, and that *R. acuminata* may be found in more elevated, and perhaps also more arid localities. Notes on the work of Uhler, Abbott and Hungerford. Figures of strigil, central lobe of seventh abdominal tergite, right and left parameres, and forewing. Ocotlan and Tizapan, Jalisco.

1931. China, *An interesting Relationship between a Crayfish and a Water Bug*: pages 60-62.—Eggs of *Ramphocorixa acuminata* (*balanodis*) on *Cambarus immunis* and *C. acutus*. A review was given of the explanations of the relationship by Forbes, Abbott and Hungerford, and the true explanation was connected with aëration of the eggs (Hungerford). Figures of egg-bearing crayfish, enlarged egg, and male of *R. acuminata*. Ponds of Mississippi Valley.

1933. Poisson, *Quelques observations sur la structure de l'oeuf des insectes Hémiptères-Hétéroptères*: pages 29, 31.—The egg of *Rhamphocorixa acuminata* was described as semi-cylindrical and figured. It was noted that "Chez ces Hémiptères aquatiques l'oeuf est fixé à un support (minéral, végétal, quelquefois même à un autre animal aquatique)."

This was, in effect, the last printed record discovered for our water boatman, since the notation in Comstock's text (1940) is the passage from the original edition (1924). There are doubtless many interesting unwritten observations on a species so widely distributed and easily recognized by the marked sexual dimorphism, and with such a curious egg-laying habit. Fairly general acquaintance with the egg masses on the crayfish has been found in conversations in the field, though the supposed identity of the covering has ranged from "moss" to the eggs of the crayfish, itself.

DISTRIBUTIONAL NOTES

In the Francis Huntington Snow Entomological Collections, there are unusually fine series of both species of *Ramphocorixa*. *R. acuminata* is best represented from Kansas and Texas, but is apparently well distributed throughout the Mississippi Valley, with outposts in Minnesota in the North, the District of Columbia and Alabama in the East, Colorado in the West, and extending far south into Mexico (Puebla). New records for *R. rotundocephala* show this species in the tropics of Puerto Rico, and widely distributed through Mexico, reaching into Arizona. The record in Utah (McAtee, 1922) may also apply to this species.

All the localities for *Ramphocorixa acuminata* are in the so-called Austral Region of Merriam. Before proceeding farther, it may be well to recall the division of this Region into particular Zones, as follows:

Zones	Arid (Faunas)	Humid (Faunas)
Transition	Transition	Alleghanian
Upper Austral	Upper Sonoran	Carolinian
Lower Austral	Lower Sonoran	Austroriparian

Localities for *Ramphocorixa rotundocephala* are in the Tropical regions of the Greater Antilles and probably of Mexico, and in the Sonoran faunas of Mexico and Arizona. A faunal list of the specimens of *Ramphocorixa* in the Snow Collections may be of interest and service in discussing the distribution of the genus. The records of *R. acuminata* from the United States are listed under their respective faunas. Those from Mexico belong to the Sonoran, as far as can be ascertained.

Ramphocorixa acuminata (Uhler)

ALLEGHANIAN FAUNA

MINNESOTA. *St. Paul*, Elks Golf Ponds, H. B. Hungerford, 7/14/21, 7 ♂♂, 9 ♀♀.

CAROLINIAN FAUNA

KANSAS. *Atchison Co.*, R. H. Beamer, 7/11/24, 6 ♂♂, 16 ♀♀, 7/25/24, 1 ♀; E. P. Breakey, 7/15/24, 2 ♂♂, 11 ♀♀. *Douglas Co.*, Robert Guntert, 10/28/21, 1 ♀; William E. Hoffmann, 1/23/21, 1 ♀, 5/10/19, 1 ♀; H. B. Hungerford, 2/23/21, 1 ♀, Stubbs Pond, 4/8/21, 7 ♀♀, Rock pool, 5/31/16, 2 ♀♀; P. B. Lawson, Trap Light, 6/21/28, 1 ♂, 1 ♀, 7/22/30, 1 ♂; 900 ft., 7/09, 4 ♂♂, 8 ♀♀. *Lawrence*, L. S. Henderson, Trap Light, 7/35, 2 ♂♂, 7 ♀♀. *Topeka*, H. B. Hungerford, 5/26/23, 4 ♀♀; R. H. Beamer, 5/26/23, 1 ♂. *Osage Co.*, C. O. Bare, 6/23, 2 ♂♂, 6 ♀♀; R. H. Beamer, 6/23, 1 ♂, 3 ♀♀, 6/15/23, 3 ♀♀. *Lyon Co.*, C. O. Bare, 6/23, 3 ♂♂, 2 ♀♀. *Bourbon Co.*, R. H. Beamer, 800 ft., 1915, 1 ♀. *Allen Co.*, Wm. E. Hoffmann, 4/24/21, 1 ♂. *Woodson Co.*, Wm. E. Hoffmann, 2/24/21, 7 ♀♀. *Montgomery Co.*, R. H. Beamer, 798 ft., 1916, 3 ♀♀. *Republic Co.*, R. H. Beamer, 7/11/35, 1 ♀. *Saline Co.*, L. C. Woodruff, 7/14/23, 2 ♂♂, 6 ♀♀; R. H. Beamer, 7/18/23, 1 ♂, 9 ♀♀. *Medora*, L. D. Anderson, 7/3/27, 1 ♂, 1 ♀; R. H. Beamer, 7/2/27, 1 ♂, 1 ♀; P. A. Readio, 7/2/27, 4 ♂♂, 6 ♀♀. *Barber Co.*, R. H. Beamer, 1468 ft., 1916, 3 ♀♀.

UPPER SONORAN FAUNA

KANSAS. *Decatur Co.*, F. X. Williams, 2560 ft., 1 ♂. *Logan Co.*, F. X. Williams, 3322 ft., 1 ♀. *Wallace Co.*, F. X. Williams, 3440 ft., 1 ♂. *Morton Co.*, C. O. Bare, 8/2/24, 1 ♀; 7/20/24, 2 ♂♂, 3 ♀♀.

COLORADO. *Hadley*, P. A. Readio, 9/22/27, 1 ♀.

TEXAS. *Randall Co.*, R. H. Beamer, 7/7/27, 1 ♀.

AUSTRORIPARIAN FAUNA

ILLINOIS. *Olive Branch*, Owen Bryant, 9/5/23, 2 ♂♂, 2 ♀♀.

ALABAMA. *Crawford*, Paul W. Oman, 7/24/30, 1 ♀.

MISSISSIPPI. *Lauderdale*, R. H. Beamer, 7/17/30, 2 ♂♂, 14 ♀♀. *Ocean Springs*, C. J. Drake, 7/29/21, 1 ♀. *Vicksburg*, C. J. Drake, 7/19/21, 3 ♂♂, 3 ♀♀. *Woodville*, 7/26/21, 3 ♂♂, 5 ♀♀. *Scooba*, R. H. Beamer, 7/17/30, 1 ♀.

OKLAHOMA. *Tulsa Co.*, Grace Wiley, 3/16/22, 1 ♂, 1 ♀. *Ardmore*, H. B. Hungerford, 4/14/23, 3 ♂♂, 25 ♀♀.

TEXAS. *Dallas Co.*, D. D. Millsbaugh, 3/2/39, 2 ♂♂, 1 ♀. *Athens*, Millsbaugh, 12/5/38, 1 ♂, 2 ♀♀. *Colorado Co.*, Grace Wiley, 4/22, 32 ♂♂, 97 ♀♀, 1 5th instar, 5/22, 71 ♂♂, 128 ♀♀, 11/11/22, 1 ♂. *Harris Co.*, R. H. Beamer, 8/12/28, 1 ♀. *Beasley*, L. D. Tuthill, 11/7/32, 18 ♂♂, 24 ♀♀. *Brazoria Co.*, L. D. Beamer, 8/12/28, 4 ♂♂, 8 ♀♀. *Victoria*, Garcitas Creek, L. D. Tuthill, 11/8/32, 1 ♀. *Sinton*, L. D. Tuthill, 11/8/32, 19 ♂♂, 43 ♀♀.

LOWER SONORAN FAUNA

TEXAS. *Colorado City*, L. A. Stephenson, 7/17/27, 1 ♀. *Eastland Co.*, Grace Wiley, 4/29/21, 2 ♂♂, 8 ♀♀, 5/21, 77 ♂♂, 472 ♀♀, 7 5th instars, 1 4th instar, 6/2/21, 1 ♀. *Jim Wells Co.*, R. H. Beamer, 7/24/28, 3 ♀♀. *Alfred*,

R. H. Beamer, 7/24/28, 6 ♂♂, 5 ♀♀. *Brooks Co.*, R. H. Beamer, 7/25/28, 2 ♂♂, 3 ♀♀; J. G. Shaw, 7/25/28, 2 ♂♂. *Falfurrias*, L. D. Tuthill, 11/2/32, 1 ♀. *Starr Co.*, J. G. Shaw, 7/30/28, 15 ♀♀; R. I. Sailer, 7/5/38, 3 ♂♂, 18 ♀♀. *Cameron Co.*, J. G. Shaw, 8/3/28, 1 ♀. *Hidalgo Co.*, E. I. Beamer, 8/14/28, 1 ♀; J. G. Shaw, 8/3/28, 5 ♂♂, 5 ♀♀; L. D. Tuthill, 11/22/32, 1 ♀. *Del Rio*, H. D. Thomas, 1937, 2 ♂♂, 8 ♀♀.

MEXICO (SONORAN FAUNAS)

SAN LUIS POTOSI. Km. 447 on road to *Loredo*, Nr. Valley San Luis Potosi, No. 42, H. D. Thomas, 9/28/38, 5 ♀♀.

AGUASCALIENTES. Five miles south *Aguascalientes*, Smith & Dunkle, 7/16/34, 1 ♀.

JALISCO. Twenty miles S. *Guadalajara*, H. D. Thomas, 9/10/38, 5 ♂♂, 1 ♀, *Tequila Rd.* 28 mi. N., 9/13/38, 1 ♀. *Tecolotlan*, H. D. Thomas, 9/15/38, 1 ♂, 4 ♀♀, 9/17/38, 1 ♀; L. J. Lipovsky, 9/16/38, 5 ♀♀.

MICHOACAN. *Patzcuaro*, H. D. Thomas, 8/31/38, 1 ♀. *Carapa*, H. D. Thomas, 9/2/38, 3 ♀♀. *Morelia*, H. D. Thomas, 9/3/38, 2 ♂♂, 6 ♀♀, 9/4/38, 23 ♂♂, 26 ♀♀. *Zamora*, H. D. Thomas, 9/8/38, 3 ♂♂, 6 ♀♀, 9/9/38, 3 ♀♀. *Zacupu*, L. J. Lipovsky, 9/1/38, 1 ♀. Twenty miles E. of *Zitacuaro*, 9/28/38, H. D. Thomas, 2 ♂♂, 3 ♀♀.

HIDALGO. *Real del Monte*, H. D. Thomas, 9/23/38, 1 ♀, No. 29; L. J. Lipovsky, 9/23/38, 1 ♂, 2 ♀♀.

VERA CRUZ. West of *Jalapa* 15 klm., H. D. Thomas, 7/18/37, 1 ♂, 1 ♀.

PUEBLA. *Tehuacan*, H. D. Thomas, 7/18-25/37, 20 ♂♂, 15 ♀♀. *Cacaolapan*, H. D. Thomas, 7/22/37, 11 ♂♂, 10 ♀♀.

Ramphocorixa rotundocephala Hungerford

TROPICAL FAUNA

AQUIDILLA, PUERTO RICO. Near *Isabela*, Julio Garcia Diaz, 5/12/35, 14 ♂♂, 47 ♀♀ (Plesiotype ♂).

SONORAN FAUNAS

CHIAPAS. *Comitan*, Octavio Utrilla L., 1/18/38, 1800 M, 1 ♂; H. D. Thomas, 8/30/37, 13 ♂♂, 40 ♀♀. *L. Tepancuapan*, H. D. Thomas, 8/28/37, 1 ♂. *Ocosucuanilla*, H. D. Thomas, 7 ♂♂, 9 ♀♀.

VERA CRUZ. *Santa Lucrecia*, M. F. (Dampf), 11/9/30, 1800, 1 ♂, 1 ♀.

MICHOACAN. *Carapa*, 9/8/38, 3 ♀♀.

JALISCO. *Tecolotlan*, 9/15/38, 2 ♀♀.

SONORA. *Salitral Rio Mayo*, H. S. Gentry, 2/23/35, 1 ♂, 1 ♀.

ARIZONA. *Baboquivari Mts.*, R. H. Beamer, Jr., 7/16/32, 5 ♂♂, 1 ♀.

These lists do not include the many specimens of *Ramphocorixa acuminata*, in all stages and seasons, which I have taken in eastern Kansas from 1935 to the present date (Table I). Also, through the kindness of Dr. H. B. Hungerford, several older corixid collections were made available. The most of the material found there had been noted in the literature outlined in the historical synopsis; but some records of *R. acuminata* may be added: Prentiss, Ohio, 7/17/16, C. J. Drake, 1 ♂, 1 ♀; Victoria, Texas, at light, 7/16/12, B. R. Coad, 1 ♂; San Jose, Tamps., Mexico, April, 1910, 3 ♀♀. Three

♀ ♀ from Normal, Ill. (P. R. Uhler Coll., U. S. N. M.) were labeled *C. obliterata* Uhler, and the specimens labeled *Corixa scutellata* (noted by Bueno) were found. The types selected by Abbott for *Ramphocorixa balanodis* were examined: a male labeled "St. Louis, Mo., October 1911" and a female labeled "Columbia, Mo., VII, 1909, J. F. Abbott."

TABLE I. *Ramphocorixa acuminata* in Douglas County, Kansas

MONTH.	Egg.	Nymphal instars.	Adult.
January			1/22/38
February			2/26/38
March			3/7/37
April	4/18/38		4/8/36 4/18/38
May	5/10/36 5/23/37 5/31/37	5/19/37 3, 4, 5 5/20/37 3, 4, 5 5/23/37 3, 4, 5 5/31/37 3, 4, 5	5/7/36 5/7/37 5/9/36 5/10/36 5/19/37 5/20/37 5/23/37 5/31/37
June	6/13/36 6/16/36	6/3/37 3, 4, 5 6/13/36 3, 4, 5 6/15/36 3, 4, 5 6/16/36 3, 4, 5	6/3/37 6/13/36 6/15/36 6/16/36 6/18/36 6/19/36 6/21/36 6/22/36
July	7/14/41	7/11/41 4, 5 7/14/41 3, 4, 5 7/16/36 4, 5 7/18/36 5 7/20/36 3, 4, 5	7/11/41 7/14/41 7/16/36 7/18/36 7/20/36 7/25/36
August		8/10/36 3, 4 8/29/41 3, 4, 5	8/2/41 8/10/36 8/29/41
September	9/8/37 9/9/37 9/29/35	9/1/40 3, 4, 5 9/5/36 5 9/9/36 5 9/9/37 3, 4, 5 9/10/37 3, 4, 5 9/15/37 3, 4, 5 9/18/37 3, 4, 5 9/26/37 3, 4, 5	9/1/40 9/5/36 9/9/36 9/9/37 9/10/37 9/15/37 9/18/37 9/26/37
October	10/3/37 10/23/37 10/24/37	10/1/37 3, 4, 5 10/3/37 3, 4, 5 10/14/37 3, 4, 5 10/31/37 3, 4, 5	10/1/37 10/3/37 10/14/37 10/23/37
November	11/1/35	11/7/37 5 11/26/37 5	11/7/37 11/8/35 11/14/37 11/26/37
December	12/30/37		12/30/37

With the accumulated data, the suggestion (Jaczewski, 1931) that *Ramphocorixa* was originally Sonoran, spreading subsequently eastwards toward the Atlantic coast, would seem supported, in part. The greatest differentiation of the genus, as known, is in the Sonoran faunas where it has at least two species, and both are most numerous there. Individuals of *Ramphocorixa acuminata* are rare in the Alleghanian fauna (and probably the Transition), and plentiful in the Carolinian and Austroriparian, particularly in the southern and western portions grading into the Upper and Lower Sonoran faunas, where the corixid is strikingly abundant. In the literature the species has been reported most frequently from the Carolinian and Austroriparian, but the areas occupied by these faunas are notably those most thoroughly collected until recent years.

Pasture ponds and comparable water holes are typical in Sonoran areas, and *Ramphocorixa acuminata*, in turn, is typically a resident of such water bodies. The preference is at least susceptible to explanation by inheritance, and this would entail an exceedingly long history in the plains pond habitats. Ponds and shallow lakes, often amazingly extensive, have been features of the Mexican landscape for an untold number of years. Here are found incredible amounts of corixid bugs, including those long-famous species of *Corisella* which have supplied the natives with food through many centuries. *Corisella* also accompanies *Ramphocorixa* in Kansas pasture ponds.

Prevailing southerlies often sweep across the southwestern plains regions during the drier seasons (May-October) when the ponds are evaporating and the corixids are migrating. Insects do not necessarily fly with the wind (Lutz, 1927), but it is probable that the dispersal of our species has been hastened and assisted by these persistent currents. Felt (1938) describes the importance of convection—"nature's escalator"—in lifting insects high above hot, bare areas, where they may join the through traffic on the wind, until some new factor, individual or meteorological (Wilbur, 1939), induces a landing. The increase in the number of artificial ponds may assist in providing way stations. (See Whitfield, 1939, for an excellent bibliography on insects and wind.)

It is thus possible to picture the origin of *Ramphocorixa acuminata* in the Sonoran Southwest (probably in Mexico) and its distribution northeastward through the Mississippi Valley. This leaves the question of the other species and the origin of the genus. *R. rotundocephala* is evidently well distributed through the Greater Antilles and Mexico, north to Arizona. The prevailing winds, and hurricanes (Tannehill, 1938), sweep across these areas from east

to west, following the chain of islands into the peninsula of Yucatan or crossing the Gulf into the Mississippi Delta region. If these wind currents have served at all in distribution, it was probably in this direction, out of the islands and on to the continent. The appearance of the males of the two species would seem to indicate *R. rotundocephala* more nearly approaches the generalized corixid type, and is probably the older species. The suggestion is that *Ramphocorixa* was originally an island or Neotropical form, which entered the Sonoran areas of Mexico through its tropics, and found there inducement for the specialization and subsequent distribution which have given the Middle West a most interesting water bug.

PART 2—THE LIFE OF THE WATER BOATMAN

"There seems to be little doubt that any organism, man included, is born with a certain equipment in the way of capacity or ability. Environment may give the organism the opportunity to bring this to the greatest possible function. . . . All that science has been able to say about the organism is that it is a 'coördinated, self-perpetuating system of activities.' Its primary quality is continual activity. Like environment it is always changing."—Pearse (1932).

SOME ASPECTS OF THE STUDY

An honest historian must often hurdle the obstacles of prejudice, hearsay, misinformation, and stubborn opinion, before reaching the simple truth. The writer of a *life history* must also draw the fine lines between fact and opinion, normal and abnormal, observation and interpretation—sorting and fitting together the pieces of information from field and laboratory, and keeping himself out of the picture, as much as possible. In this, the living habits of *Ramphocorixa acuminata* may seem attended with peculiar difficulties of collection and study.

The pasture pond is at best a variable, even a most temporary, water body: drought may force the adult corixids into unpredictable flights, leaving the nymphs and eggs to meet abnormal conditions or perish. Nor do the adults wait upon drought, but migrate often for less accountable reasons, thereby disturbing the proportions in the pond population. The question of proportions must in turn disturb the collector, who attempts a fair estimate of the stages and numbers present from the limited catch which can be taken. The nymphs of *Ramphocorixa* in the beginning stages, for example, are extremely small and may be missed altogether.

All stages are protectively colored and active, while the water

of their normal habitat is frequently discolored and darkened by debris kicked up from the bottom or dropped in from above by wading livestock. (Note also the reflection of their surroundings by such glossy submerged animals, in Ward, 1920.) Day to day observations must be made in the laboratory. The fragile bodies are easily weakened or broken, and mortality is usually high in experiments involving transportation from pond to aquarium. Here some agility is needed in studying the restless corixids under proper magnification. Adults may fly from the containers, or suffer fatal injury against a cover. The data on individuals are always subject to sudden interruption by the high mortality among confined representatives of all stages.

Finally must come the assemblage of the results of observations and experiments performed in a variety of conditions with a variety of success, to form a logical whole susceptible to reasonable interpretation. In this final assemblage of facts and probability, there is the problem of distinguishing normal reactions and activities from abnormal findings resulting from the abnormal conditions of confinement, whether in the aquarium or in a drying pond.

With all these difficulties, the study of the life of a water boatman is calculated to inspire the worker with an enthusiasm serving to surmount the most of the obstacles. (Note Abbott, 1912; Hungerford, 1917, etc.) The insect is one to which there is attached no human prejudice, for the conduct of its affairs in no way obstructs or makes unpleasant the course of mankind's doings. It is somewhat beneficial as a desirable fish food. Its patterns and coloration are harmonious, even beautiful, and the whole effect of the insect is one of trimness and efficiency. Indeed, as pointed out by Kirkaldy (1908), the Corixidae seem to have gained more complete mastery over the problems of aquatic existence than any of their relatives, judging by their numbers. The water boatmen have been successful in a number of curious habitats: in brackish water ponds and pools at dry Tortugas (Pearse, 1932a), in salt water (Hutchinson, 1931), and in hot springs (Brues, 1932).

In addition, *Ramphocorixa acuminata*, with which this study deals particularly, lays its eggs upon crayfish—surely, here is an instance worthy of inclusion in the chapter of Dixon and Eddy (1925) on "Strange Associates"! The peculiar habit is of such unique and interesting nature that it has been discussed again and again in entomological literature, as indicated in the preceding section. But the last word has not been written, nor will be in this

treatment. In this changing world of fact and opinion, a monograph may add a chapter, but it will never conclude the history of a species.

THE CORIXID-CRAYFISH ASSOCIATION

THREE THEORIES

In view of the extreme interest attached to the habit of oviposition upon crayfish, it is appropriate that attention should have centered upon that phase of the life history, and that the egg-laying habit was the introduction of *Ramphocorixa acuminata* to entomological literature. It is not surprising to find that certain definite opinions have been formulated by different authors to explain the interesting association. Three theories have been published, and the latest and most ingenious of these is now widely accepted. The theories may be quoted from the literature cited in the preceding section:

(1) *Protection of eggs from drought by the migratory habit of the crayfish* (S. A. Forbes, 1878). "I can account for so strange a habit only by supposing that it is a 'provision of nature' to guard against the waste of eggs otherwise resulting from the drying up of the ponds. The crawfishes mentioned are distinctively aquatic species, and as one pond dries up they migrate to another, or to a neighboring stream, bearing on their hospitable backs, as the shepherd bore Oedipus from impending destruction, the hopes of the distressed water bugs."

(2) *Protection of eggs from enemies by the pugnacious nature of the crayfish, and a theory of symbiosis* (J. F. Abbott, 1912). "The investiture of eggs commingled with debris certainly renders the crayfish less conspicuous and it probably profits by the arrangement in much the same way as do various shore-crabs which are decorated with sponges, algae or coelenterates. Whether the water bug improves its chances against racial extermination by the adoption of such a pugnacious protector it may be too much to assume, but at any rate whatever the utilitarian value of the habit it must be of the same nature as that which obtains in the widely distributed genus, *Zaitha*."

(3) *Aëration of the eggs, largely through activity of the gills of the crayfish* (H. B. Hungerford, 1919). "When we study the respiration of the crayfish we find that a current of water is kept passing beneath the carapace and over the gills. This water enters the gill chamber from the rear, passing directly by the abdominal pleurites. The current would be strongest at the first abdominal pleurite, and

it is just here that we find the first eggs. . . . The eggs, therefore, are placed upon the crayfish in the region where there are the best chances for aëration. If only crayfish heavily burdened were examined, it would not be so apparent, but . . . if the oviposition be light, it is obvious at once that there is a choice coincident with the region bathed with the freshest water."

Summary. It is evident that the logic of natural selection has been applied in these three theories. Certain benefits are supposedly derived from the attachment of the eggs upon the crayfish; we must then infer that the habit has become fixed through infinite time by the elimination of the individuals which missed these advantages. Through protection from drought, enemies or stagnation, we are led to believe that the eggs of *Ramphocorixa acuminata* survive best upon the crayfish, and the theory of aëration benefits is particularly well supported. However, from additional observations and experiments, there evolves another possible interpretation of the relationship between the crayfish and the water bug (p. 273). The groundwork for this new theory may be found in the following descriptions and notes.

THE EGG

The egg of *Ramphocorixa acuminata* was described by Abbott (1912): "Length, about .9 mm. Breadth, about .4 mm. Shape, elongate-oval, bilaterally rather than axially symmetrical, *i. e.*, one side nearly straight, the opposite strongly curved. Colour grayish yellow (later stages only were observed); the surface ornamented with a delicate tracery in the form of interlocking hexagons like a honeycomb or the facets of a compound eye. The egg is fastened in a sort of shallow cup which is of a leathery texture and dark brown in colour. The distal end through which the nymph emerges is provided with six to eight short lobes arranged in a circle. The appearance of the whole egg is much like that of a minute *Grantia* sponge." To this description Hungerford (1919) added that "the ovum has a transparent button and tip, while the body of the egg is yellow," and Poisson (1933) mentioned the egg of *Ramphocorixa* briefly as "semi-cylindrique."

The length of the new-laid egg is about .85 mm., including the small buttonlike tip but not the pedestal; the latter increases the length to about .9 mm. The diameter of the new-laid egg is .35 mm.-.4 mm., increasing with the appearance of the eye-spots before eclosion. The color is ordinarily a creamy-yellow, though there is much variation and the egg-shell may be affected by stains or dis-

figured by clusters of microörganisms and debris. A clean shell appears smooth and polished under low-power magnification. High-power and transmitted light show the minute hexagons described by Abbott (Fig. 1.). These are mostly irregular, and there are many pentagons, as well. About 30 of these figures would form a chain around the greatest diameter. The figures are often irregularly placed, however, and form neither perfect bands nor spirals, becoming particularly irregular at the tip. They do not separate when the egg is broken, but tear across irregularly. Under high magnification the egg-shell surface appears pebbled or roughened with many tiny protuberances.

In side view, the small distal nipple is discovered with high magnification to be made up of numerous long processes. These and the distal plates form a tiny rosette when viewed from directly above. The finger-like appendages are respiratory filaments, according to Poisson (1933), and concealed within the rosette are the micropylar canals. This interpretation seems to agree as well for *Ramphocorixa* as for the other genera studied by Poisson, who stated: "La disposition des appendices pneumatiques, des micropyles, et du disque de fixation reste la même dans tous les oeufs que j'ai pu examiner."

The pedestal of the egg resembles the rubber suction disks used to attach objects to smooth surfaces. The egg is fastened to the disk by a thick, elastic tendon, resting in a small cupped protuberance upon the circular base. The disk is usually a light brown.

Eggs dissected from the female are exactly similar to the new-laid eggs, though the diameter is commonly somewhat less and the color more yellow. The pedestal is here a short, elastic extension ending in a small, thick disk—all quite clear. It is evident that the brown, leathery appearance is given the pedestal when it is attached by a thick coating of a cementing fluid. In *Ramphocorixa* there are commonly 10-12 fully developed eggs in the abdomen at one time, plainly visible through the cuticula, packed tightly against the body wall. Butler (1923) has reported taking 20 eggs from the body of a female *Corixa geoffroyi*, and the bodies of *Arctocorixa* females in this region may contain a dozen or more. While *Ramphocorixa* is smaller than the latter genus, the eggs are fully as long, though of less diameter; however, as many as 22 eggs may be contained, appearing deeply indented by the pressure against one another in the packed abdomen. The dissections were made among specimens collected both in July and in September. Even though the larger number of eggs contained be the rule rather than the exception, it must

be realized that many individuals play a part in thoroughly covering a crayfish (Fig. 2).

The egg-laying of *Ramphocorixa acuminata* has been observed in the balanced aquarium (p. 297). Butler (1923) described the oviposition of *Corixae*, as follows: "In depositing an egg, the ♀ grasps the leaflet or portion of the plant selected, with the first two pairs of legs, and then a longitudinal motion of the abdomen is observed, the tip resting on the spot where the egg will be laid. During this movement, the minute drop of the fluid which affixes the egg to the plant is emitted and placed in the desired position; the egg is then laid with the micropyle farthest away from the point of attachment, and the ♀ swims away. Several days may be occupied by a single ♀ in laying her batch of eggs, the number deposited daily decreasing."

Strength of attachment. Anyone familiar with the habits of crayfish will immediately realize the necessity for a firm attachment of the water bug eggs, if they are to ride safely through constant sliding into burrows, lunges toward prey, and vigorous backward dashes through pond waters laden with silt and debris. Abbott suggested that the eggs rested in shallow pits in the crayfish cuticula, but this must be considered exceptional or accidental, and owing to the normal roughness of the crayfish coat. The pedestals may be pried away with a needle, especially after being soaked in alcohol for some time; on the living crayfish, a vigorous scraping is needed to loosen the egg-bases. The tendon commonly weakens first in nature, the egg then dropping off and leaving the disk upon the crayfish, enclosed in the brown coat of glue. This does not mean that the short tendon is weak; it is highly elastic and amazingly strong. A fairly large crayfish (45 mm.) may be picked up and waved about by simply gripping an egg firmly with forceps and hauling the creature aloft!

The elasticity of the connecting fiber is as amazing as its strength. A *Ramphocorixa* (or *Corisella*) egg may be held with forceps and another pair used to separate the base from the body of the egg, connected only by a clear, elastic fiber. This may be stretched as much as .3 mm. and will spring back into position when released. The roughest treatment does not affect the elasticity of the ligament, as long as its elastic limit is not surpassed. It may be drawn out to that point many times with very little weakening, and a hard tug is needed to pull the base completely away. The procedure may be performed in water or alcohol.

The eggs of *Ramphocorixa acuminata* are often deposited on the appendages of crayfish, where they are constantly moved about and brushed against objects, though receiving little attention from the crayfish, beyond an occasional aimless plucking. The strength of the fibrous pedestal and the attachment of the base are somewhat weakened after hatching, and the eggs may drop off their bases or detach entire. But crayfish have been kept over winter from December to March, losing very few of the hundreds of eggs upon them, though eclosion occurred in early January and the crayfish were rolled about in a forceful current several times each week. It is evident that eggs freshly deposited with a firmly adhesive base and a springy, stout pedestal are definitely "put on to stay."

The egg shell is also tough and flexible. Eggs must be vigorously squashed to be broken, and probably sustain severe bumps without injury. But they quickly fall victim to desiccation when exposed to the air. The quick drying of corixid eggs is amply illustrated by any of the accounts* of *ahuautle* collecting in Mexico, where the natives dry immense quantities of the eggs upon flat, hard ground. In a few hours, eggs taken from pasture ponds and dried are completely beyond recovery. The shell collapses and indents deeply upon one side. When returned to water, the eggs float on the surface and do not hatch.

THE CRAYFISH

The irascible temperament of the crayfish is so eternally displayed that the ovipositing of *Ramphocorixa* seems comparable to the courageous feeding of tiny tick birds in the crocodile's mouth—even more dangerous, for the birds are protected by the indulgence of the reptile, by most accounts. It is hard to conceive just how the eggs are sometimes laid bordering the mouthparts. Coupled with its irascibility, the crayfish possesses an insatiable appetite. It is well-described by Huxley as "a voracious and indiscriminate feeder," and in the aquarium will senselessly founder itself, if given too large quantities of food. The crayfish commonly partakes of small fishes and *water insects*, which may lead us to wonder if it might not find *Ramphocorixa* tasty.

On several occasions crayfish have been observed to stalk and devour the adults, feeding chiefly at night. The nymphs are also eaten—even first instars when these are confined with the crayfish in a bowl. On crayfish taken in December, the eggs must have

* Say (in LeConte, 1859), Figuiet (1872), Glover (1877), China (1931), Hagner (1936), and others. Also described by H. D. Thomas, Kan. Acad. Science meeting, Pittsburg, 1938, with motion pictures. The eggs, or "water wheat," are used in making flour or marketed as bird food.

produced several hundred nymphs (judging from examination of the shells), but none was ever found on the mornings following eclosion.

We may suppose a strong and vital stimulus provokes the approach of the female *Ramphocorixa* upon the crayfish for oviposition. It will be remembered that the female *Belostoma* accomplishes her egg-laying upon the male despite his struggles, and her persistence is thought motivated by the eggs' need for aëration. This provides the cue for considering the aëration possibilities of the crayfish and their relation to the positions chosen for the eggs.

Branchial currents. The gills of the crayfish lie in chambers above the leg-bases, covered by lateral flaps of the carapace, called "branchiostegites" by Huxley (1880). A current is drawn forward beneath these covers by a curved plate (scaphognathite) working near the anterior opening on each side. This small baler was interestingly described by Huxley, who compared the usual action (three or four vibrations per second) to ordinary breathing, and fast action to panting. His observations were made on the common European crayfish, *Astacus fluviatilis*; similar results have been obtained for the lobster (Calman, 1911).

An appreciable current must pass continually over the primary laterotergites of the abdomen and the lateroposterior parts of the carapace, as the water is drawn across these areas in entering the branchial chambers. Simple experiments will demonstrate this current. A small crayfish may be guided into a tilted position in the angle of wall and bottom of a bowl, so that the side of the animal is horizontal. When minute fragments of chalk and bits of paper are placed upon the areas mentioned and upon other parts, in the regions washed by the branchial current the debris is visibly stirred and gradually slips away, while remaining in the other positions. If the powder of dried ink is placed in the water near the posterior opening into the gill chamber, delicate streamers will be drawn through and passed out by the head. Here the current is particularly strong, and the water constantly ripples, especially when the animal is alarmed. When taken out of water, the crayfish bubbles conspicuously at the anterior openings.

PREFERENCES IN OVIPOSITION

In the literature of *Ramphocorixa*, eggs have been described on *Cambarus immunis* Hagen, *C. blandingii acutus* Girard, and the subgenus *Cambarellus* Ortmann—usually on the first species. Papers on crayfish were explored for additional records, without success. Among these were the works of J. A. Harris, whose collec-

tion was made available by C. D. Bunker and given a thorough going-over (Table II). In the fourteen species and four varieties of *Cambarus* studied, only three determined species (*C. immunis*, *simulans*, and *virilis*) bore eggs of *Ramphocorixa acuminata*. These are crayfish of ponds and water holes, though the latter two are found as commonly in streams. Half the crayfish bearing eggs were

TABLE II. Corixid Eggs on Crayfish in the Harris Collection

SPECIES OF CRAYFISH.	No. exam.	Size* (mm.)	With eggs.	Size* (mm.)	♂ ♂	♀ ♀
<i>Cambarus</i> sp.	331	27-92	47	44-91	9	38
<i>C. virilis</i>	120	23-102	1	90	1	.....
<i>C. gracilis</i>	81	31-85	.....	.....	.....	.....
<i>C. immunis</i>	58	35-100	40	50-100	19	21
<i>C. neglectus</i>	26	35-75	.....	.....	.....	.....
<i>C. simulans</i>	20	40-89	6	67-85	4	2
<i>C. diogenes</i>	16	41-114	.....	.....	.....	.....
* <i>C. nais</i>	15	33-74	.....	.....	.....	.....
<i>C. obscurus</i>	14	40-75	.....	.....	.....	.....
<i>C. bartonii</i>	11	44-70	.....	.....	.....	.....
<i>C. immunis spinirostris</i>	7	40-60	.....	.....	.....	.....
<i>C. pilosus</i>	6	80-85	.....	.....	.....	.....
<i>C. affinis limosus</i>	5	68-77	.....	.....	.....	.....
<i>C. bartonii robustus</i>	4	57-76	.....	.....	.....	.....
<i>C. blandingii acutus</i>	4	55-85	.....	.....	.....	.....
<i>C. monongalensis</i>	4	47-67	.....	.....	.....	.....
<i>C. rusticus</i>	3	40-60	.....	.....	.....	.....
<i>C. carolinus</i>	3	48-65	.....	.....	.....	.....
Totals	728	.....	94	.....	33	61

* Size = length, tip of rostrum to extremity of telson, of the smallest and the largest specimen in each series.

undetermined but mostly recognizable as *C. immunis*; of the named specimens, forty out of forty-seven belonged to this species, which is most widely distributed and common in ponds. A large proportion of *C. immunis* carried the eggs of *Ramphocorixa*: forty specimens of the fifty-eight examined. Probably the importance of this crayfish to the corixids is primarily due to its presence typically in the pasture ponds of areas inhabited by the bugs. But other factors must be involved, such as periods of exuviation and time of appearance in the ponds. For example, *C. gracilis* is a pond-dwelling species, but retires frequently to burrows, and Harris (1902) noted that it is

rarely found as an adult in open water during the summer. Several crayfish from eastern Arkansas carried the eggs of our corixid, adding another state to the distributional list. The Harris collection also added two new records of crayfish species used as egg-bearers: *C. virilis* in Missouri (a single and probably exceptional instance) and *C. simulans* in Kansas.

In the Limnology collection (Kan. Univ. Entomology Dept.) two of the fourteen crayfish examined carried *Ramphocorixa* eggs. These were *Cambarus blandingii acutus* from Oklahoma, the only species other than *C. immunis* from which the corixid eggs have been previously reported. Creaser and Ortenburger (1933) described the ecology of the species: "This crayfish frequents stagnant water. Bogs, slowly moving streams and rivers and ponds are its favorite habitat. Sometimes this crayfish builds a shallow burrow when the water-level falls in the ponds during dry seasons." Lonnberg (1898, in Harris, 1903) noted that "The late Capt. C. Eckman, at Savannah, Ga., collected *Cambarus (blandingii)* in the hollow trunk of a fallen tree, two English miles from any open water." The specimens bearing the eggs are recorded from North Canadian River, but this may not indicate the presence of *Ramphocorixa* in the stream, since the crustaceans may have been collected in neighboring ponds or have migrated from them to the river.

In Table II, the crayfish bearing corixid eggs are fairly large, the average about 75 mm. in length. But this must not be taken to show a preference for larger specimens. Collections from Eastern Kansas pasture ponds through the last few years would place the average length between 25 mm. and 50 mm. Twelve representative specimens have been chosen from the collections (Table III).^{*} Eight of these (Nos. 1-8), from two ponds, are *Cambarus simulans*, and the remaining four, from another pond, are *C. immunis*. Since collections were made for the most part with a dip net, not a seine, the proportions of these species are less truly representative. However, *C. simulans* must predominate in certain ponds, rather than the widely distributed *C. immunis*. The ecology of the former species was described by Creaser and Ortenburger: "This crayfish lives in

^{*} Areas on the crayfish in Table III are designated according to the following key: Ro, rostrum; AC, anterior carapace (before cephalic groove); PC, posterior carapace (behind cephalic groove); A 1-6 abdominal segments 1-6; Te, telson; OU, outer uropod; IU, inner uropod. Positions of corixid eggs within these areas are indicated by: L, left; D, dorsal; R, right; a, anterior; p, posterior; l, low; h, high; i, inner portion (of uropod); o, outer portion (of uropod). Thus, AC-L = anterior carapace, left, low; PC-Lal = posterior carapace, left, anterior, low; A 1-L = 1st abdominal segment, left; Te-a = telson, anterior; OU-L = outer uropod, left, inner portion.

The eggs sometimes found upon the appendages have not been tabulated (excepting the uropods). Eggs are laid on the chelifers, peripods, the bases of the antennae and eyes, and even upon the maxillipeds—but only occasionally. The anterior appendages more commonly bear eggs than the posterior.

TABLE III Eggs of *Ramphocorixa acuminata* on *Cambarus*

No	1	2	3	4	5	6	7	8	9	10	11	12
Lengths*	53	48	59	46	31	27	42	39	22	22	23	21
Sex	f	m	m	f	m	m	m	m	m	f	m	f
Ro*	24		1		12	2	8	25	10	6		4
AC-Ll	44				3			30				1
AC-Lh	30				3			36	13	2		
AC-D					3			30	17	10		1
AC-Rh	4		1		26			24	9	17		
AC-Rl					12			32				
PC-Lal	42							32		9		
PC-Lah								25	12	7		
PC-Da								27	10	4		
PC-Rah					7			26	5	7		
PC-Ral								30		7		
PC-Lpl								10		7		
PC-Lph			3					3	13	6		
PC-Dp								3	10	6		
PC-Rph								15	3	1		1
PC-Rpl								32		12		
A1-L						1		2		3		
A1-D												
A1-R							2		1			
A2-L	16	11	10		1	7		9	7	7		
A2-D						1			4	5		
A2-R	17	12		2		2	10	7	7	8	2	1
A3-L	6					2			8	8	1	
A3-D									5	3		
A3-R	7	5				3	10		7	9	1	
A4-L	4					5			4	6	3	
A4-D									2	2		
A4-R							4		4	7		
A5-L				1		4			6	7	5	
A5-D										3	2	
A5-R							1		6	6	1	
A6-L						1			2	5	4	
A6-D										2	2	2
A6-R										3	1	1
Te-a			2						1	3	1	1
Te-p									6	10	5	1
OU-Ll			6						2	6	4	2
OU-Lo									1	7	5	
OU-Rl				3					2	5	5	
OU-Ro									2	10	3	3
IU-Ll			4					3	3	7		5
IU-Lo										5	3	1
IU-Rl									2	4	4	
IU-Ro									1	6	3	
Totals	194	28	27	6	67	28	35	401	185	249	55	23

* Length in mm—tip of rostrum to extremity of telson Abbreviations in footnote, p 270

much the same ecological situations as *C. blandingi acutus*. It seems particularly fond of muddy streams and ponds. When these ponds dry during midsummer the crayfish resort to burrows. This species is not essentially a burrowing species, however."

In long series of all sizes, the crayfish show certain areas bearing eggs with fair consistency, though often with a small proportion of the total eggs present. (cf. Hungerford, 1919.) The preference thus indicated is as follows:

(1) The laterotergal plates of the second abdominal segment.

(2) The carapace posterior to the cervical groove, along the lower margin on either side, and particularly in the lower posterior areas.

(3) The carapace anterior to the cervical groove, usually lateral

and upon the rostrum. The anterior portion of the carapace may often be covered completely by a mat of eggs.

LIMITATIONS OF THEORIES

Forbes (1878) suggested that the corixid eggs are rescued from drying ponds by the migrating crayfish. If this relationship exists, it is decidedly imperfect. The eggs have been found on four crayfish species; of these, the most migratory has been chosen least. The water bugs make no distinction as to size, though small crayfish might not be equal to sustained trips overland. Nor would the eggs, in all probability, endure a long trek; they are quick drying and do not remain viable afterward. Preference does not guarantee a suitable destination—willful or unfortunate excursions would menace, more than help, the survival of our corixid. The crayfish may not choose to migrate, preferring to sink a shaft, erect a chimney and wait for the rains. These cheerless excavations are often poorly supplied with water in which the crustaceans remain but a part of the time. Nymphs hatched or carried in would meet insurmountable problems in avoiding the lumbering crayfish and digging out a living.

Abbott (1912a) explained the "symbiosis" of the corixid and *Cambarus* as *protective*—the crayfish being camouflaged by the cover of eggs and, in turn, defending them. In comparing the habits of *Ramphocorixa* and *Belostoma*, he also suggested aëration. The pugnacity of the crayfish is unquestionable, but there are some misgivings as to the protection it affords. In the collections from pasture ponds, there are commonly specimens with one leg or more missing, lost in some passage at arms. One, heavily laden with corixid eggs, had only three posterior legs remaining attached, obviously powerless to protect the eggs, or itself. In a well-lighted aquarium where some concealing investiture was surely desirable, the attitude of the crayfish toward the ovipositing water bugs was discouragingly predatory. Both nymphs and adults of *Ramphocorixa* are acceptable to the crayfish palate, although there is no instance of removal or devouring of the eggs. The dangers which the females encounter in oviposition might be concluded to balance fairly the advantages derived by the eggs from the "pugnacious protector." However, the water bug may deposit its eggs at any time, and may have opportunity to approach the crustacean during a somnolent interval. The enemies from which the eggs are to receive protection may be represented by the abundant notonectids, which have been observed to prey upon the eggs of *Belostoma* (Severin, 1910), for

example. But to such swift predators, the crayfish must be a questionable deterrent; indeed, *Cambarus*, successfully approached by *Ramphocorixa*, might be approached by *Buenoa* or *Notonecta*, and others, in turn, and the crayfish would then serve in the capacity of an ambulatory lunch counter.

Hungerford (1919) demonstrated a choice in oviposition coincident with areas washed by gill currents, and proposed that aëration benefits account for the habit. The logic is particularly attractive, since *Ramphocorixa* and *Cambarus* frequent ponds with characteristic stagnation and filth. The respiratory filaments (p. 265) suggest the importance of aëration, and the positions chosen fit this interpretation. However, it does not explain all the facts related to oviposition. China (1931) introduced his discussion by describing several adaptations of water bugs for aërating their eggs; but the habit of *Ramphocorixa* is not quite in the same category. In the other cases (aside from actual structural developments, as in *Nepa* and *Ranatra*), there are *invariable* relationships: *Belostoma* and relatives, for example, always oviposit on the backs of the males. The adaptation for aëration—and possibly protection—is immutably fixed in the behavior pattern. But *Ramphocorixa* may or may not oviposit in the favored positions on the crayfish, and may oviposit without recourse to that animal. Perhaps the “instinct” of the water bug is imperfect; a majority of successes is all that the theory requires. However, many instances suggest another factor which may influence the relationship.

THE FACTOR OF CONVENIENCE

The water bug obviously deposits eggs upon the crayfish when this animal is available—perhaps *because* it is available. This suggestion of availability, or convenience, as a factor in the relationship grows from the following observations:

(1) *Conditions of the pasture ponds.* These are usually shallow, with a bottom of trampled ooze, stirred and pulverized by wading or wallowing livestock. Vegetation, loose sticks and stones are rare, and mostly covered with silt and debris.

(2) *Association of Cambarus and Ramphocorixa.* Both notably prefer the water hole type of habitat, and are found together in the shallows—the corixids pasturing on the algae and other micro-organisms, and the crayfish preying on the insects, and one another.*

(3) *Crayfish as convenient egg supports.* Oviposition in Corixi-

* Association as a factor in the choice of the oviposition site is rather curiously shown by Bare's report (1926) of *Notonecta undulata* laying upon *Ranatra* (a “stick-like” insect)! The eggs were successfully hatched, though the *Ranatra* succumbed.

dae requires a firm, fairly smooth surface upon which the egg pedestal may be glued. Such surfaces are not plentiful in turbid water holes—excluding the crayfish. Their bodies are firm and smooth enough; they are frequently in motion and extricate themselves from mud and debris. Their convenience is recognizably conditioned by jaws and nippers.

(4) *Notes and experiments.* Eggs of *Ramphocorixa* have been reported on molluscs (Forbes), tin cans, boards, living snails, sticks, and floating plants (Hungerford). In the past several years, they have been found on water plants, sticks, a tin lid, the whorl of a snail shell, the carapace of a painted turtle. "Egg-traps" of small bottles on cords, weighted to bob freely just off the bottom, found favor with species of *Arctocorixa*, *Corisella* and *Ramphocorixa*. Our corixid preferred the pieces of sandstone used for weights, the others the cords and bottles. A large screen cage, found exposed in a typical pond by the lower September water level, bore masses of eggs on the screen and tin top. Those exposed to the air were collapsed and brittle, but the others were fresh and in good condition. The screen of one side (about 40 x 20 cm.) was taken to the laboratory in a pail of pond water. The eggs were massed, one on the other, in columns, dendritic arrangements and thick grapelike clusters. Approximately 730 were counted on one representative square centimeter, with deposition on both sides of the screen. About half of these were eggs of *Ramphocorixa*, and the rest of *Corisella*. Nymphs hatched from both in aquaria, and reached the adult stage (p. 287).

Crayfish are sometimes rare in the shallows of ponds where eggs of *Ramphocorixa* have been found on other objects. *Overcrowding* may also explain the choice of alternative oviposition sites, where crayfish are plentiful, and has been suggested (Hungerford, China) to explain extra heavy egg coverings on individual crayfish. Two aquarium experiments are of interest in this connection. In June, several gravid water bugs were confined with a medium-sized crayfish. Numerous eggs were deposited upon leaves of *Vallisneria* and the aquarium wall, one or two inches from the bottom, but none on the crayfish, touring in and out of an improvised den. In September, a crayfish was fastened† in an aquarium where the water bugs were ovipositing upon *Vallisneria*. These plants and the aquarium walls received additional eggs, but not the crayfish, and corixids feeding near showed no interest. Sometime before, in the same

† A copper wire was passed about the cephalothorax and the ends extended through a glass tube. This was attached at the edge of the aquarium and the crayfish suspended just off the bottom.

aquarium, a determined female *Belostoma* cornered her mate and coated him with eggs.

Present convenience alone will not explain the relationship of Ramphocorixa and Cambarus. Other corixids have equal chance to oviposit upon crayfish, and sometimes do; eggs of *Arctocorixa*, *Corisella* and *Trichocorixa* species have been found, but these deposits number in dozens, not in hundreds and thousands. At present in pasture ponds, these genera show preference for plant stems and fragments, and *Ramphocorixa* for the crayfish. In the long association of the latter two animals in water holes, the availability of the crayfish might be concluded to have ingrained the preference in the water bug (Wardle, 1929: 87); but more difficult to explain is the choice of certain areas for oviposition. Aëration benefits must surely be received in the currents at the entrance and exit of the gill chamber, but the choice of these positions is, as yet, curiously facultative, and far removed from the obligatory habits of other water bugs concerned with aëration. Perhaps the preference is condition by the effect of branchial currents, and the action of legs and tail, in clearing these areas of debris. Availability easily accounts for the numerous eggs found upon the fore portions of the body (eyes, antennal bases, chelae, maxillipeds), since these regions normally protrude from shelters when the crayfish are at rest.

Summary. The eggs of *Ramphocorixa acuminata* are preferably deposited upon crayfish, usually *Cambarus immunis* and *C. simulans*. These species are typically associated with the corixid in water holes. The oviposition habit is not obligatory, amounting to a fixation of choice in the behavior pattern of the insect, in which preference extends to areas affected by branchial currents. Protection of eggs from drought and enemies are possible benefits accruing from the association; aëration by branchial currents may be a factor in the choice of special areas; while the convenience of the crayfish in long association with the ovipositing water bugs serves largely to explain the relationship.

THE LIFE CYCLE IN PONDS

The adults of *Ramphocorixa acuminata* may mate and lay eggs in the aquarium; these eggs may successfully incubate; nymphs may hatch, feed, molt and grow to maturity. Here studies are concerned with individuals and aquarium conditions. The life of the species must be studied in the natural environment, subject to normal physical and biological influences. These vary greatly, according

to the seasons, pond conditions, and the coincidence of organisms. Life histories are often presented in charts, neatly apportioning the year among the various stages, with nothing left out or left over. In the life history of our corixid, chapters frequently overlap, with eggs, nymphs and adults side by side through favorable periods until winter disposes of the less hardy stages. The proportions of instars in long series of collections must solve the problem. Generations overlap, but the greater number will be found in a particular stage in a given season, with the special goal of development, growth, maturation or reproduction.

Opportunity to study the life cycle in the open invites the collector in this region of Kansas. Ponds are numerous in Douglas county (p. 244). Those in easy distance from the road (near the University and the historic Hole-in-the-Rock) were regularly examined. The ponds supporting *Ramphocorixa acuminata* are alike in these respects: They are artificial pools, fed by pasture drainage and intermittent streams, rather than by springs and seepages; frequented by livestock; and bottomed with ooze, rich in microscopic life. The associated species form the typical community described in Part 1 (p. 245).

In shallow pasture ponds, the two great ordeals during the year are drought in summer and solid freezing in winter. *Ramphocorixa* is well adapted to evade or withstand these difficulties. The least enduring stages of growth usually appear in the favorable seasons of spring and autumn, while the adults are most prevalent during summer and winter. There are exceptions because of overlapping generations, but, for the most part, *Ramphocorixa* offers an excellent example of the fitting of a life history within a special environment.

Spring, when the mask of ice lifts at last, is the most interesting season of all. How has the species fared through the winter? What stages of the life cycle will be found? Such questions invite the collector to the ponds. "First appearances" there are often related with difficulty to hibernation. Adults may be collected in small numbers throughout the winter and in early spring. They reach a peak in abundance during May and June, in some ponds bringing *Ramphocorixa acuminata* into a position of numerical dominance. But the increase of adults must be preceded by growth stages in comparable numbers. The earliest record of nymphs in the collections (Table I) is May 19, when third, fourth and fifth instars were taken, indicating that eclosi3n, for the fifth instars, at least, occurred sometime in April. The earliest record of eggs is April 18, perhaps overwintered

deposits (p. 279); the next, May 10, both hatched and recently deposited. The third stadium of *Ramphocorixa* may be reached fairly quickly after hatching—a fortunate condition, for the minute earlier stages are not obtainable in ordinary collecting. Oviposition accompanies the ascendancy of the adults in the ponds, and eggs are common on crayfish in May and June.

Summer. As a rule, the eggs hatch rapidly (p. 288). Within a week, nymphs may appear and busy themselves in the quick march to adulthood, their progress correlated with the approach of drought. In ponds doomed to extinction in late July and August, the sun must exercise increasing influence upon the organisms of the oozes supplying the corixids with food, and the warmth of the water undoubtedly speeds up development. There may be an unfavorable increase of predators to contend with, but the nymphs have sure agility in escaping these marauders, which are usually after larger game. Thus our species, in part, at least, obtains wings in ample time to salvage its existence by flight. Often in the hot sunshine, which has reduced a pond much below its spring level, corixids have been observed rising from the surface in short, whirling excursions. An extension of these "test flights" would bring about such corixid showers as those reported by Lange (1905), Richardson (1907) and McAtee (1922). Day (1927) described migrations from drying Cumberland ponds.* Migratory flights of *Ramphocorixa acuminata* are frequently indicated by the appearance of the species in isolated ponds and the pools of drying stream beds, in correlation with disappearance of the winged forms in neighboring ponds overtaken by drought; and by re-appearance of the adults in ponds refilled by fall rains. Complete drought is not the rule, but rather the frequent mischance in summer. When it occurs, even the adults lie thick on the mud—food for the killdeer. In those ponds which may suffer a reduction in volume, but otherwise hold their own through the dry season, the larger nymphal instars and the adults are abundant through the late summer, as the species nears its second main period of oviposition.

Fall. In this season, mating and oviposition are as extensive as in the spring. On September 9, numerous specimens of *Cambarus simulans* were found in a small pond, each with a supply of *Ramphocorixa* eggs. Oviposition in this pond evidently continued through the fall, almost to the winter period. On the same date, thousands

* Poisson (1921) described the flight of corixids from overheated laboratory containers; but the same author (1924) gives an account of flight at 15°. The detailed observations of Richardson are particularly interesting.

of eggs were discovered attached to a screened box (p. 274). Crayfish bearing eggs are common in September and October.

Mating was observed in a large pond (September 9),† when exclusion of livestock from the pasture allowed the water to become fairly clear. In the eastern shallows, opposite the high earth dam, many *Ramphocorixa* and *Corisella* were discovered in the bright sunlight. The depth of the water was six inches to one foot, the temperature about 78° F. The observations were made from 2:00 to 3:30 p. m. When side by side with the females (and heading the same direction), the males mounted with a quick, hopping movement. Often this coupling was only for an instant, though females were observed carrying mates for longer periods. Males were seen in pursuit, with heads almost touching the female abdominal apex, following thus for several feet until a pause on the part of the female gave opportunity to mount. One male mounted two females in rapid succession, staying with each but an instant. Another pursued a female for a distance, lost her in the hollows, and mounted another, feeding nearby, for a brief moment. The male then resumed feeding, and the female never ceased its bobbing activity. The females seemed remarkably passive when mounted; the usual indication of recognition of the male's presence was simply a particularly emphatic bobbing movement in the feeding. In some cases, however, there were definite efforts toward evasion. A female swimming by seemed often a challenge to a feeding male, which then took up the pursuit. Indeed, one hapless male was observed patiently following behind a mammoth female *Corisella*, but had no success in mounting. (Larsen, 1938, noted attempts by males to mate with other males.) Throughout the observations, the corixids were busy with the rich ooze, feeding rapidly and continuously. They came rarely to the surface. In half an hour of watching, one male was observed to rise to the top. The corixids seemed quite sensitive to jars; stamping on the mud, a foot from the water edge, caused swift, darting changes of position among perhaps a third of the feeding water bugs.

† Larsen (1938), in a thorough discussion of reproductive structures and habits of water bugs, has given the following information for European species of Corixidae: The water boatmen regularly have short copulation periods, *Corixa dentipes*, *C. geoffroyi*, *Sigara sahlbergi*, and *S. linaei* in late March and early May. *Sigara striata* and *Callicorixa praestata* have a short copulation period in spring and another in summer, with two generations a year. In *Cymatia*, the period begins in middle May, lasting into June. *Micronecta minutissima* overwinter as nymphs, becoming adults in June, with mating in late June and early July. The females of *Corixa dentipes* and *C. geoffroyi* have one long reproductive period, lasting through till spring. Hagemann (1910) showed one generation for *C. geoffroyi*, overwintering as adults and dying in early summer shortly after copulation. The males were said to remain attached 1-2 days. Larsen described the actual copulation as less than one hour, though Butler (1928) gave several hours duration for Corixidae. See, also, p. 296 for aquarium studies.

The adults and larger nymphal instars show no marked decrease, as a rule, until cold weather definitely arrives, usually in November. The nymphs drop first from the collections, and then the adults are greatly reduced, though some continue through the winter season.

Winter. Ordinarily, *Ramphocorixa acuminata* is less available in this season than the associated species of *Arctocorixa* and *Corisella*, particularly the former. However, adults may be found through the winter, even swimming beneath the ice. On February 26, a large pond was invaded through a thick ice coat, and the corixids were fished out, accompanied by numerous water beetles (chiefly *Hydroporus* and *Laccophilus*). Specimens were secured from the same pond in temporary thaws, December 30, January 22, and March 7. There is no doubt that the species passes over the winter in the adult form;* but whether or not this is the only normal hibernating stage may be questioned.

On December 30, three specimens of *Cambarus simulans* were drawn from a small pond partially covered by ice. These crayfish bore each a liberal supply of *Ramphocorixa* eggs upon the carapace and the abdominal laterotergites, in the usual positions. Since the eggs did not appear to be hatched, the crayfish were placed in deep glass bowls and supplied with water. The temperature was much higher than that of the pond (4.1° C.) and results were immediate. Within the week, the eggs began hatching, and continued to hatch well into January. The crayfish devoured the larger parts of the nymphs, but there is no doubt concerning the identity of the eggs and the eclosion.

It seems reasonable that the development of the eggs normally would be much retarded by cold in the natural environment. In this case, development might well be prolonged through January and February into March, with eclosion in March or April. It is not improbable that overwintering eggs may help augment the quantities laid by hibernating adults, and contribute to the ascendancy of *Ramphocorixa* in the late spring. The possibility that nymphal instars safely pass the winter might be suggested. (Hungerford, 1919, recorded third instar nymphs of *Palmocorixa buenoi* wintering at Ithaca, New York.) If so, the instances must be rare, for even sifting floor mud of the ponds has failed to disclose nymphs later

* Adult corixids have been reported under ice by Westwood (1840), the specimens inactive and clinging to one another; by Kirkaldy (1898) in masses; by Bueno (1903), *Corixa harriisi*; and by Weesenberg, (in Brehm, 1930), who recorded great numbers of the adult water bugs, but never the nymphal forms. Howard (1905) gave the adult as the hibernation stage, and noted that specimens captured in the spring are frequently coated with mud; Kellogg (1905) also stated that the adults hibernate in the mud. See Larsen (1938) in footnote, p. 278.

than November. The first two instars might escape attention, but their fragility and normally quick development seem inconsistent with winter survival.

Summary. *Ramphocorixa acuminata* has two marked periods of oviposition in late spring and early fall, indicating a two-generation cycle. The spring peak in egg laying is preceded by growth stages which may result from eggs deposited in late fall or early spring. The occurrence of both eggs and adults through the winter may suggest the interpolation of a third generation. (Hungerford, 1917a, suggested several generations a year for a species of *Arctocorixa*.) More probably, confusion has arisen from overlapping generations. There are two significant peaks in oviposition during the year, but more than a month is involved in each case. Those eggs laid in the first part of the period produce nymphs which may be well toward the terminal stadia by the time the eggs deposited later are hatching. Eggs laid in late summer and early fall produce the hibernating imagoes; other eggs deposited in late fall may have time only to produce nymphs, which are probably destroyed by the cold; still others may not hatch until spring.

ECLOSION

There is no more fascinating maneuver in the life of *Ramphocorixa* than the emergence of the nymph from the egg. Eclosion apparently takes place at all times of the day, but favorite hours seem late at night and early in the morning. In the early hours of September 11, the following observations were made of eggs hatching on the telson of a small crayfish.

2:30 a. m. The tip of an egg has just opened, with four irregular flaps peeling back. The round top of the head bulges slowly upward, covered with a thin membrane. In the center of this covering, between the eyes, is an exact circle of tiny dark patches with a comparatively thick fragment at the top of the circle toward the dorsum (that is, toward the incurved side of the slightly bent egg, Fig. 12). Suddenly the membrane splits and glides rapidly to one side. The nymph is emerging. The legs are tucked against the body, the middle and hind pairs trailing. The body bends and strains. In these movements, the forelegs are thrust forward together, then down against the body. The nymph expands rapidly, even while emerging, and is out in a moment. Immediately it is much too large for the egg. (cf. Figs. 5, 11.) The movements are feeble, but strengthen noticeably in a quarter of an hour. The nymph is now twice the length and breadth of the shell. It rests at first

against the flaps of the shell, facing the light, and then on the crayfish, beside the egg and facing the other way. Another nymph (hatched 1:00-2:00 a. m.) also rests nearby, after swimming vigorously about when the light was first turned on.

2:50 a. m. The tip of one egg appears as illustrated (Fig. 13). A moment later, the membrane parts and the head emerges, swelling and pulsing, with the eyes immediately widening apart. The front legs appear, parallel and extending caudad. They move away from, and then toward, the body slightly, as movements similar to peristalsis (but swelling, rather than contracting) push the body free (3:10 a. m.). At once the hatched nymph dwarfs the egg. It is quite transparent and the slow movements of its organs are perceptible. Only a moment is needed for emergence, after the parting of the membrane bearing the circle of patches, but the peeling back of the flaps occupies several minutes.

Two additional eggs opened at 2:50 a. m. One of these is illustrated (Fig. 14) at 3:00 a. m. A distinct pulsing, as of the dorsal vessel, showed in the head. The membrane parted at 3:12 a. m., and one full minute was required for emergence. The muscular movements in emerging are remarkable. The body swells anteriorly, and this swelling passes repeatedly toward the egg base with slow bendings, thus forcing out the nymph.

3:23 a. m. The condition of this egg resembles Fig. 14. The membrane parts so that the thick, dark fragment slips to the right. Emergence is at 3:38 a. m., one full minute and twenty-one pulsations of the body being required. The swimming legs slowly unfold and thrust out to the sides, while the front and middle legs remain limp for a minute or two. The middle legs then quickly begin service as clinging organs.

3:46 a. m. The pattern of this egg tip also resembles Fig. 14. Twenty-one pulsations, through one minute, are required for emergence. The movements begin, as in the other cases, instantaneously with the parting of the membrane covering the head.

Our corixid has made its debut as a free agent in the world, and clings near the egg to the handy back of the crayfish. On this frail being, teetering on fragile underpinnings and already beginning to kick vigorously with the swimming legs, there now rests the burden of ceaseless vigilance and eternal trenching in the long, hard way toward maturity.

THE INSTARS

DESCRIPTIVE NOTES

The minute, transparent first and second instars are rarely taken from ponds, although their high mortality would require them to be numerous. But the larger nymphs may often be found in numbers equaling or excelling the adults. The instars are easily separated with a 12 \times handlens,* and no more magnification is needed for recognition of *specific* characters. After wing-pads and color pattern appear (third instar), it is practicable to determine the common species of nymphs in the field, once they have been linked with the adults. The problem here amounts to a distinction of genera. Rearing experiments have necessarily established the identities of *Ramphocorixa*, *Arctocorixa*, *Trichocorixa* and *Corisella* nymphs, since adulthood with the addition of wings considerably disturbs the nymphal patterns. Three characters, at least, are usable in separating the genera of corixid nymphs: size, color pattern, and appearance of the dorsal glandular patches on the abdomen.

With consideration of size (Table IV), a few notes may be given on form. All nymphs are broadest across the middle, about the third abdominal segment; head and tail are truncations of a boat shape. The body tapers more abruptly caudad, particularly in the fifth instar, where head width increases in proportion to body width and the sides of the thorax build out with enlarged wing pads. The proportions of the body are to some extent generic in significance, *Ramphocorixa* being noticeably the slenderest. Corixid nymphs seem quite flat, due to the compressed abdomen and the opisthognathous head. The lateral portions of the abdomen, especially in the early instars (Figs. 5, 6), are so thin that the medial portion is distended into a prominent lobe containing the vital organs, a condition reminiscent in appearance of the Devonian trilobite *Phacops*.

The sternal regions of corixid nymphs are commonly light-colored—yellow, stramineous, orange or brownish—and do not admit easily recognizable generic distinctions. But the tergal portions are characteristically ornamented with generically separate variations of the general color scheme. The head harmonizes with the ventral color, with a dark mesal point and tuft of hairs on the rim of the vertex. The narrow portion of the prothorax, exposed dorsally when the head is bent down, is covered with fine hairs and has a dark caudal rim.

* *Third instars* have short wing-pads, the first pair reaching but half the length of the thorax; *fourth instars*, medium pads, the first pair reaching the length of the thorax and almost to the tips of the second; *fifth instars*, long wing-pads, the first pair reaching the tips of the second and exceeding the length of the thorax. (Figs. 7-9.)

TABLE IV. Dimensions of Nymphal Instars collected from Kansas Pasture Ponds *

INSTARS.	Dimensions.	Corisella.	Aretosoriza.	Ramphocoriza.	Trichocoriza.
5th.....	length.....	5.883 \pm .081	4.950 \pm .045	4.596 \pm .022	3.837 \pm .034
	width.....	2.430 \pm .034	2.097 \pm .023	1.815 \pm .022	1.608 \pm .015
	head width.....	1.965 \pm .030	1.842 \pm .018	1.620 \pm .013	1.365 \pm .012
4th.....	length.....	4.128 \pm .024	3.564 \pm .020	3.474 \pm .026	2.730 \pm .020
	width.....	1.893 \pm .014	1.841 \pm .006	1.479 \pm .011	1.230 \pm .020
	head width.....	1.545 \pm .009	1.422 \pm .010	1.311 \pm .009	1.062 \pm .007
3d.....	length.....	2.967 \pm .010	2.505 \pm .019	2.610 \pm .020	.....
	width.....	1.530 \pm .008	1.254 \pm .004	1.194 \pm .004	.....
	head width.....	1.236 \pm .007	1.062 \pm .005	1.047 \pm .002	.....

* Dimensions in mm. from nymphs in 80 percent alcohol. Averages from random samples of ten individuals, the ocular micrometer measuring .3 mm. at 42.5x. Probable error by the Bessel formula.

The dorsal borders of the wing pads are furry with a thick, dark growth of fine hairs, forming an M along the sides and the cephalic margin of the pterothorax. The body in general is less conspicuously hairy (Fig. 9).

A light mesal line extends across the thorax and cervix to the vertex. Along this line, masked in part by the hairiness of the anterior pterothorax, the exuviae divide in molting. Two pairs of light dashes extend on either side of the line into the brown coloration on the mesothoracic tergum. The first abdominal tergite is edged caudally with dark brown; light brown and straw colors continue on the abdomen in a pattern of darker medial and lateral patches set off by lighter areas. In the middle of the third, fourth and fifth abdominal terga, with orifices opening in the posterior margins (bowed forward at this point), are the characteristic dorsal glands.* The first of these seems vestigial, but the second and third are conspicuous bean-shapes and crescents, varying from bright red to darker blood tones. The transparency of the corixid nymphs renders these peculiar bodies of importance in descriptions of abdominal patterns.

With this introduction to general appearances, the generic characters of the larger instars may be summarized in an expanded key. Fifth instars are usually most available, and show the characters best.

* Kunkel d'Herculais (1895) suggested the glands indicate relationship with the Cimicidae. Gulde (1902) claimed the conspicuous dorsal markings were not indications of glands, but merely the sites of certain abdominal muscle insertions! The descriptions of Hagemann (1910) and Brindley (1928; see footnote, p. 817) may be cited particularly. Brief observations were made by Krüger (1909). The glands appear in many terrestrial and aquatic hemipterans, as described by these authors and others. Summaries are given in Weber (1930) and Beler (1938). As indicated by Poisson and Jacewski (1928), the dorsal glands are relatively less developed in the fifth instar, anticipating replacement by the ventral metathoracic gland in the adult.

- 1(a) *The lateral posterior margins of the mesothoracic tergum* (where the bases of the wing pads curve mesad) *are distinctly hairy*. The light dashes on the metathoracic tergum are like *Corisella* (2a). The median abdominal color patches are plainly set off by light inverted crescents on the third abdominal tergum and succeeding. The lateral color patches are usually edged by a pair of light lines from the tips of the wing pads to the abdominal apex, joining there to form a conspicuous V next the smoky margins. The dorsal glands are commonly heartshaped, bright red, about $\frac{1}{4}$ - $\frac{1}{2}$ of the body width (e.g., 0.31 mm. : 2.0 mm.). In comparison with other genera, the fifth instars are medium-sized (4.9 mm. x 2.1 mm.); the head (1.8 mm.) and body widths are in the ratio of 6 : 7.

ARCTOCORIXA (viz. *alternata*).

- 1(b) The lateral posterior margins of the mesothoracic tergum are bare. The abdominal patterns are similar, but usually obscured..... 2
- 2(a) *Two pairs of light dashes on the metathoracic tergum form an anterior bar, touched by a plain posterior V*. The dorsal glands are bean-shaped, a dark blood color, about $\frac{1}{2}$ of the body width (e.g., 0.42 mm. : 2.52 mm.). Fifth instars are large (5.9 mm. x 2.4 mm.); the head (2 mm.) and body widths are in the ratio of 5 : 6.....CORISELLA (viz. *edulis*).
- 2(b) The light dashes on the metathoracic tergum form two V's, the anterior small and sometimes indistinct; the fore-margin of the metathorax is also light 3
- 3(a) *The dorsal glands are roughly bean-shaped, a dark blood color, and quite large, about $\frac{1}{4}$ of the body width* (e.g., 0.42 mm. : 1.58 mm.). *The brown mesal line on the vertex (which is distinctly lobular) continues in an even hairy line on the mesothoracic tergum*. Fifth instars are small (3.8 mm. x 1.6 mm.); the head (1.4 mm) and body widths are in the ratio of 7 : 8 TRICHOCORIXA.
- 3(b) *The dorsal glands are commonly minute bars or rough crescents, dark and reddish, and quite small, though about $\frac{1}{4}$ of the body width* (e.g., 0.26 mm. : 1.79 mm.). *The brown mesal line on the vertex (which is more evenly rounded) does not continue on the mesothorax*. The body proportions are less than 2 : 5 (4.6 mm. x 1.8 mm.); the head (1.6 mm.) and body widths are in the ratio of 8 : 9... RAMPHOCORIXA (viz. *acuminata*).

GROWTH IN AQUARIA

On May 27, a dozen large battery jars ($11 \times 8\frac{3}{4} \times 5\frac{1}{4}$ in.) were prepared as aquaria. These were lined upon a laboratory table where sunlight reached the first aquarium for about an hour and the others progressively less, the last three receiving no direct sunlight. The water was aerated with compressed air.† Several kinds of bottom materials were used to insure a variety of conditions for the growth of supporting organisms. The preparations were as follows:

A. (Aquarium) 1 & 2. Water (A. 1-6) from Potter Lake (a clear,

† This method was first used at the University by Robert Guntert (Naucoreids, 1926); also by C. O. Bare (Buenos, 1926), and by H. B. Hungerford with other water bugs. See Peterson (1984) for various adaptations.

rock-walled pond on the campus), May 26, pH 7.3. Ooze from a pasture pond, May 27, in a layer of about one inch, passed through a strainer to clear out most of the macroscopic organisms.

A. 3. Fragments of *Typha* from the shallows of Potter Lake, where the water was filled with cattail, *Spirogyra*, plankton scums, sticks, border plants and debris. The fragments had been soaking for several months, and were dark brown, slimy, and easily shredded.

A. 4. Ooze mixed with an equal part of ground *Typha* fragments, passed through a food-cutter which pressed out most of the liquid.

A. 5 & 6. Ground *Typha* fragments (prepared May 26).

A. 7 & 9. Water (A 7-9) from Potter Lake (May 5, pH 7.6), settled in a large jar, perfectly clear before addition of bottom material. Ooze from a pasture pond.

A. 8. Clean sand.

A. 10. Water (A. 10-12) from a pasture pond (May 6, pH 7.6), settled in a large jar, faintly tinged with yellow-green, containing large numbers of minute Crustacea, mostly Cladocera. Clean sand.

A. 11. Ground cattail fragments.

A. 12. Ooze from a pasture pond.

In each case, the ooze was from a typical pasture pond observed to support numerous *Ramphocorixa*; cattail fragments were established as a successful rearing medium by Hungerford (1919). The mixtures settled well over night, the pH varied little; but the organisms naturally required more time to reach a condition suitable for maintenance. Those commonly found in the aquaria are listed (Table V) from observations made in the fall during rearing experiments with *Ramphocorixa* and *Corisella*. The aquaria containing ground cattail were conspicuously the most successful, particularly A. 6. Bottom samples showed finely divided plant tissue, shining and gelatinous with the multitude of associated organisms. Any of these might be swept into corixid gulleets, and some of their remains were obtained from stomach contents (p. 291). Cladocera (*Daphnia*), Copepoda (*Cyclops*), and a few ostracods swam in the constant traffic of planktonts; small snails (*Physa*) and clams toiled on the bottom, where *Tubifex* worms swayed from their numerous tunnels. Nematodes, a leech, and bloodworms were occasionally removed. The larger organisms were characteristic of aquaria containing pond ooze. Immediately following preparation of the containers (May 28-June 13), the later instars of *Ramphocorixa* (in A. 1, 3), *Arctocorixa* (in A. 6, 7) and *Trichocorixa* (in A. 11) were reared to establish identities. The microorganisms fared well over

TABLE V. Aquaria Bottom Materials and Common Organisms

COMMON ORGANISMS.	A. 1, 2, 7, 9, 12: Pond ooze.	A. 4: Equal parts pond ooze and ground Typha.	A. 3: Typha fragments.	A. 5, 6, 11: Ground Typha.
Algae:				
<i>Navicula</i>	*	*		*
<i>Oscillatoria</i>		*		*
<i>Stauroneis</i>	*			*
<i>Amphora</i>				*
<i>Scenedesmus</i>				*
Mastigophora:				
<i>Notosolenus</i>	*	*		*
<i>Euglena</i>		*		*
<i>Anisonema</i>				*
<i>Eudorina</i>				*
<i>Phacus</i>				*
<i>Trachelomonas</i>				*
Sarcodina:				
<i>Trinema</i>	*		*	*
<i>Actinosphaerium</i>			*	*
<i>Diffugia</i>			*	*
<i>Buglypha</i>			*	*
<i>Amoeba</i>				*
<i>Arcella</i>				*
Ciliata:				
<i>Euplates</i>	*	*	*	*
<i>Loxophyllum</i>	*		*	*
<i>Cyclidium</i>			*	*
<i>Chilodon</i>	*			*
<i>Liometus</i>	*			*
<i>Cinetochilum</i>				*
<i>Uronema</i>				*
<i>Vorticella</i>				*
<i>Coleps</i>	*			*
Rotatoria:				
<i>Philodina</i>	*		*	*
<i>Coleurella</i>			*	*
<i>Dietylastermis</i>				*
<i>Furcularia</i>				*
<i>Monostyla</i>				*
Gastrotricha:				
<i>Chaetonotus</i>	*			*

TABLE VI. Growth of Corixid Nymphs in Aquarium 6

	Ramphocorixa.	Day intervals.		Corisella.
Eggs introduced.....	Sept. 13			Sept. 13
First instar.....	Sept. 20			Sept. 14
Second instar.....	Sept. 27	7	6	Sept. 20
Third instar.....	Oct. 3	6	8	Sept. 28
Fourth instar.....	Oct. 10	7	6	Oct. 4
Fifth instar.....	Oct. 16	6	7	Oct. 11
Adult.....	Oct. 25	9	9	Oct. 20

the summer, and were in good concentration in the fall. *Corisella edulis* and *Ramphocorixa acuminata* were then reared from eggs (Table VI).

Eggs were introduced into A. 2-7, 11 and 12 on pieces of screen wire (p. 274), about 4 sq. cm., mingled *Ramphocorixa* and *Corisella*. In A. 1, *Ramphocorixa* eggs were on crayfish exuviae; in A. 9, deposited by the water bugs on the aquarium wall. Nymphs hatched in bowls were also transferred to the aquaria (Oct. 24-Nov. 1), following the experiments with eggs, but failed to reach maturity. Observations were made in about 7 in. depth with a 7 \times binocular above. When changes were noted, the nymphs were drawn out with a large pipette, examined and measured (ocular micrometer: 0.26 mm. at 30 \times) in a small dish. The limitations of this method must be recognized in the genius for concealment of the minute, transparent first two instars, and in the overlapping of individual life histories. While A. 6 was the only completely successful aquarium, results from the others contributed significant variations considered in the summary.

Variations were also shown in spring rearing experiments with individuals in smaller containers (Table VII). Eggs deposited on *Vallisneria* in a balanced aquarium June 14-15 began hatching June 19. Strips of the plant were placed in deep bowls (B. 2, et al.), and nymphs were obtained; others hatched from crayfish collected June 13 (B. 12, 18, 19, et al.) and June 16 (B. 21, et al.). The bowls were frequently replenished with pond ooze and water.

Summary. The day intervals from eclosion to adult through the five stadia are for *Ramphocorixa acuminata*, 7, 6, 7, 6, 9; and for *Corisella edulis*, 6, 8, 6, 7, 9; in the optimum conditions of A. 6. The success of this aquarium may be considered due to the excellent supply of microorganisms flourishing among the shredded cattail. The rearing experiments of Abbott (p. 252) obtained for our corixid the intervals of 8, 8, 7-10, 7-10, 8 days. Other intervals in the aquaria were: First instar, 8, 9, and 11 days; 2d instar, 8, 9, and 13 days; 3d instar, 6, 6 and 12 days; 4th instar, 9, 10, and 16 days; and 5th instar, 16+ days (died without molting). Table VII should also be consulted. The stadia of *Corisella* showed similar variations, an extreme case being an individual in A. 3 which continued at least 25 days in the 4th instar.

The indications are that the life cycle is like a telescope, with the sections representing the stadia, each independently of variable length, in accordance with the environmental conditions prevailing

TABLE VII. Growth of *Ramphocorixa* Nymphs in Bowls

	B. 2.	B. 12.	B. 18.	B. 19.	B. 21.
Ovipos 'n.....	June 15				
Interval.....	5 days				
First Instar.....	June 20	June 23	June 23	June 24	June 24
Length.....	1.4 mm.	1.35 mm.	1.35 mm.	1.4 mm.	1.35 mm.
Width.....	0.65 mm.	0.65 mm.	0.7 mm.	0.75 mm.	0.7 mm.
Head width.....	0.55 mm.	0.55 mm.	0.55 mm.	0.55 mm.	0.55 mm.
Interval.....	6 days	3 days	5 days	4 days	4 days
Second Instar.....	June 26	June 28	June 30	June 28	June 29
Length.....	2.1 mm.	1.9 mm.	1.9 mm.	2.0 mm.	1.9 mm.
Width.....	1.0 mm.	0.9 mm.	0.95 mm.	1.0 mm.	0.9 mm.
Head width.....	0.8 mm.	0.75 mm.	0.75 mm.	0.75 mm.	0.7 mm.
Interval.....	2 days	5 days	5 days	4 days	8 days
Third Instar.....	June 28	July 3	July 5	July 2	July 7
Length.....	2.5 mm.	2.5 mm.	2.35 mm.	2.5 mm.	2.35 mm.
Width.....	1.15 mm.	1.1 mm.	1.05 mm.	1.1 mm.	1.1 mm.
Head width.....	1.05 mm.	1.0 mm.	0.95 mm.	1.0 mm.	1.0 mm.
Interval.....	5 days				
Fourth Instar.....	July 3				
Length.....	3.25 mm.				
Width.....	1.4 mm.				
Head width.....	1.2 mm.				

at the time.* The period from oviposition to eclosion also varies, 5 days being recorded for B. 2, 8+ days for B. 12, and 10+ days for others. The possibilities for variations must be many times multiplied in the pasture pond environment, subject to abrupt changes of weather and invasion by livestock, with correlative fluctuations in temperature, turbidity, chemical conditions, and food supply.

EXUVIATION

On the bottom of an aquarium containing developing nymphs, specimens are often found firmly attached by the middle legs and humped over, with a mesal cleft along the back from the vertex to the metathorax. Through this opening each nymph must attempt its entrance into the next stadium. Not infrequently it comes to grief; the dead are found in all stages of emergence. The primary instars, at least, must prefer darkness for molting, and are not easily surprised in the process.

Most interesting is the extrusion of the imago. A fifth instar was observed beginning to molt in early evening (Oct. 14), and the adult was just attaining freedom at midnight. The prothorax and anterior margin of the pterothorax of the nymph were tinged deep orange. The wing pads were bright crimson along the sides, due to the compression of the forewings within the transparent pockets. As the

* Compare the results shown by Crowell and McCay (1937), and others in the literature cited by these authors.

dorsomesal cleft widened, the wings appeared. Up to this point, the nymph could be stirred to activity, and would then reattach itself with the middle legs. The wing pads are simple pockets within which are tucked the soft wings; molting draws these slowly forth, gradually expanding. The right wing was free in this individual at 11:35 p. m.—a light orange, transparent sack, longitudinally folded in the middle. With expansion, the forewings became deep tan, with the claval suture showing distinctly white.

5:30 p. m. A nymph observed near the molting point (recognized by the distinct mesal white line on the thorax) was transferred to a bowl in a large pipette. Some force was needed in dislodging it from the pipette. This may have induced a quick molt; the nymph remained on the surface and was free of the exuviae in ten minutes. Tracheal linings trailed from the hull. The shriveled wing tips required an hour for expansion; light spaces, as if air-filled, were at the wing bases and along the claval sutures. Immediately after kicking free of the nymphal shell, the adult carried its wings extending backward, parallel to the body. It submerged and swam about briefly, then returned to the surface and remained there with the forewings at right angles to the body. The hind wings were still unexpanded, resembling crumpled linen. Apparently they dried in this condition, and the insect died on the surface.

Dissection. A fifth instar *Ramphocorixa* was taken from A. 6 and dissected in physiological saline solution. Externally, this nymph showed no abdominal asymmetry, but dissection produced from the loosened, molting skeleton the abdomen of a male with the usual peculiarities. (Note Abbott, 1912.) The forewings, carefully drawn from their pads, were shrunken, but unfolded; the hind wings were folded fanwise, with a crumpled effect. Both pairs were soft and distensible; they were easily expanded with needles, and would not then return to the previous condition. The crimson or deep orange of the forewing pads just before molting is the concentration of tannish color in the shrunken forewing, showing through the transparent cuticula.

The digestive tract seemed quite empty, the malpighian vessels large and darkened. The tract was opened in a drop of the saline solution. Within was a fluffy-appearing mass of cloudy white. Under 20× oculars and high-dry objective, this mass resolved into large cells, rounded and floating free, apparently filled with active bacteria. These organisms seemed also present in quantities within the malpighian tubules, which appeared gray-flecked and much enlarged.

Summary of molting procedure. Exuviation ordinarily occurs at the bottom, on which the nymph anchors itself with the middle legs. The act of molting is presaged by long rests between feeding periods. In the characteristic position, pulsations are observable within the legs. (Note Locy, 1884.)

A white mesal line widens upon the thôracic dorsum. The head swells away from the prothorax; a bubble seems to fill the occipital cup. The prothorax swells apart from the pterothorax, and bends down with the head. The fore part of the tergum is thus strongly arched.

The distinct median suture enters the black fringe on the fore portion of the pterothorax; this splits slowly into halves, and the pterothorax of the next instar bulges forth. The abdomen has become elongate, narrowed, and with a tight appearance. The insect draws itself out by arching movements, and kicks free of the exuviae. In the adult, the prothorax expands after molting, forming the characteristic thin, flat plate.

THE CORIXID DIET

The food of water boatmen has been a much-studied subject for debate. Corixids were described in older textbooks and journals as predators on other water insects (Glover, 1877; Girard, 1885; Cragin, 1899; Howard, 1905; Kellogg, 1905; Smith, 1906; Bueno, 1909; et al.) and even their own kind (Furneaux, 1904). These reports seem to have resulted largely from prejudice, rather than observation; although Howard stated "the beak is strong and sharp and they can pierce the tough skin of one's finger," Bueno noted "an exceedingly hot tongue," and Wood (1884) made similar remarks—lending color to the oft-repeated dictum that *all* aquatic hemiptera are "ferocious" predators. Newman (1835) had indicated the primary inconsistency, describing corixids as carnivorous, but the forelegs "unarmed"; Bueno (1916) suggested they might be herbivorous, since "not fitted with the means to seize living things." Geise (1883) had stated that the barbed mandibular stylets were used to seize simple animals. It remained for Hungerford (1917, 1919) to demonstrate that species of *Arctocorixa* and *Ramphocorixa* may be reared on diets of algae and protozoans, and are thus producers, rather than consumers (as are other bugs), in the aquatic environment. This work has been largely copied since its production—although Martini (1923) and Wolcott (1927) stated that corixids may devour mosquito larvae; Tillyard (1926) described them as

probably almost omnivorous; and Taschenburg (1929) spoke of them as hunting larvae.

In pond and aquarium, in all active stadia, the busy feeding of *Ramphocorixa acuminata* is continuous and energetic. In all their spooning of ooze past the beak, what do the water boatmen secure? To answer this question, adults and nymphs were fixed for laboratory study, and bottom material from the haunts of *Ramphocorixa* was examined microscopically. Even to the unaided eye, this flocculent mass appeared a rich chlorophyll green; protozoans and algae were thickly associated under the lens. Conspicuous among the algae were *Oscillatoria*, *Anabaena*, *Merismopedia*, *Pleurococcus*, *Achnathidium*, *Navicula*, *Amphora*, *Pleurosigma*, and *Cosmarium*; and among the Protozoa were *Lepocinclis*, *Pleodorina*, *Trichoda*, *Phacus*, *Amoeba*, *Coleps* and *Paramecium*. There were also tiny nematodes and rotifers, including *Anurea*. The majority of the organisms might be ingested by the corixids.

Stomach contents from both sexes were examined. The gut was sometimes crowded in gravid females, but a tiny packet of pulverized material was ordinarily obtainable. This was distinctly chlorophyll green, and under the microscope resolved into blue-green, green and golden particles, undoubtedly fragmentations of algal forms; complete specimens of *Navicula*, *Amphora* and *Oscillatoria* were found. A few complete rotifers (*Distylainermis*?) and many parts were also present. Certain obscure bodies were interpreted as collapsed flagellates and ciliates. The efficient grinder in the pharyngeal region (p. 310) must thoroughly pulverize the majority of the organisms before admission to the stomach. The identifiable remnants were usually from adults, which probably swallow larger, less selected portions than the nymphs. Even so, only empty hulls of the microscopic bodies remained in the stomach; the silicious tests of diatoms were cracked and empty, the rotifers variously ruptured.

Nymphs collected from ponds contained a finely divided mass of chlorophyll green. This was also true of nymphs examined from aquaria in fall rearing experiments. But in adults, remarkable clues to the food organisms of *Ramphocorixa acuminata* were found (Figs. 15, 16). Some were obviously remnants of protozoans and algae, with recognizable fragments of *Scenedesmus* and *Trinema*. Parts of rotifers were abundant, including jaws and feet of *Philodina*, *Distylainermis*, and other forms.

Summary. The presence of algal, protozoan, and rotiferan re-

mains in adult stomachs indicates for *Ramphocorixa acuminata* a diet neither wholly animal, nor vegetable. The scooping movements of the forelegs seem designed to winnow out of the ooze a nutritious salad from both kingdoms, mixed in one digestible mass in the pharyngeal grinder. The nymphs probably select their food from algae and protozoans, though Abbott (1912) suggested ostracods. They sometimes cling on the backs of other nymphs, but cannibalism has not been observed.

PESTS AND PREDATORS

The lot of the grazer is to feed the carnivore. As producers in the pond environment, the Corixidae must struggle with numerous predators and parasites. Water tigers, crayfish and minnows have been observed attacking and feeding on adult *Ramphocorixa* in aquaria. Backswimmers soon hunt out the water boatmen in small containers; many must fall victim to these rapacious water bugs in pasture ponds (Weed, 1890).

Corixids are fancied by many vertebrates (not excluding man, p. 267). Forbes (1888), in studying the food of fresh-water fishes, found that "true water-bugs . . . were generally rare, with the exception of the small soft-bodied genus *Corisa*, which was taken by one hundred and ten specimens, belonging to twenty-seven species, most abundantly by the sunfishes and top minnows." Corixids are probably third on the preferred bill of fare of the numerous tiger salamander larvae in North Dakota lakes and ponds.* A female *Ramphocorixa* was taken with *Corisella edulis* and *Buenoa* from the craw of a pintail duck. † Our species must be eaten by the birds which feed on relatives in similar environments. Wetmore (1916) listed *Corixa reticulata* from the lesser scaup duck, killdeer, sandpipers, Wilson's snipe, ani, woodpecker and grasshopper sparrow. This corixid made up 57.5 percent of the stomach contents of the lesser yellow-legs at Cabo Rojo (Puerto Rico), and over 50 percent in the blacknecked stilt. Danforth (1926) gave the gull-billed tern, snowy egret, white-rumped sandpiper and ani as corixid eaters. In Kansas, flocks of killdeer commonly haunt the borders of pasture ponds where *Ramphocorixa* are feeding in abundance.

The parasites are not as well recognized. Banks (1939) reported nematodes from *Corixa geoffroyi*, Larsen (1938) in *Cymatia bonsdorffi*. Tiny red hydrachnid mites are sometimes found on *Arctocorixa* and *Ramphocorixa* on the dorsal abdomen under the wings. (Also observed by Larsen on *Cymatia coleoprata*.) Nymphs are

* Personal communication by Dr. Horace Telford. † By Dr. H. B. Hungerford.

often seen in awkward association with small clams, with the minute shells clamped on the long abdominal fringes or flipping along on the tip of a leg; stalked protozoans (*Opercularia* et al.) are also carried, but the significance of such chance relationships can probably be summed up in *carpe diem*.

OBSERVATIONS IN THE AQUARIUM

Before we leave our study of the life of *Ramphocorixa acuminata*, it may be interesting and profitable to spend a few hours with the water boatmen in a balanced aquarium, where eelgrass, *Elodea* and some tangles of *Spirogyra* luxuriate above a layer of sand covered with rich pond ooze. It is early spring, and the corixids have been taken from the still, cold waters of a pasture pond. The temperature of the aquarium is much higher (23.5° C.), the pH (7.6) about the same. The rectangular five-gallon container stands by a south window; on one side, a 7 × binocular microscope on multiple joints permits the observer to follow most activities within.

SELF MAINTENANCE

March 30, 2:00 p. m. The aquarium is flooded with sunlight; two lumbering snails are plowing along the bottom near a small group of water boatmen, busy and intent on their meals. A male is singled out, furiously digging, sinking lower and lower, until its belly lies on the bottom. The fore tarsi (palae) rotate around one another like twirling thumbs, and between the wide-spread anchoring middle legs a dredge-stream of ooze pours backward. The corixid bobs vigorously, glistening beautifully in the sun; the smooth, streamlined vertexal keel forms a proud crest for this glossily armored underwater knight. The oarlike hind legs at rest extend laterally backward, but are continuously passed forward, across the dorsum, and back along the sides. The film of air over the body must be affected in some way by this action. The hind legs have been observed to pry up the wing tip and press down the abdominal extremity, exposing a silvery air sheet beneath the wings. At intervals, the movements of the palae are interrupted, and the insect seems to contemplate the mass in these twin gathering baskets, as if selecting preferred tidbits.

2:45 p. m. Direct sunlight no longer reaches the aquarium. An uneasy female bats its head rapidly upon the glass, but presently resumes feeding. Another is being stalked by a grim, snaky water tiger, twice as long as *Ramphocorixa*. Its jaws are nearly touching the water boatman when it strikes. The bug almost casually avoids the vicious bite, and re-settles not far away. The beetle

remains motionless for a few seconds, its head twisted in the direction of the corixid's departure, and then trundles into an algal tangle for another strike, its "tail" flipping up with the lunge.

3:15 p. m. The corixids congregate next the window, generally facing the light. A female wildly scurries up the glass wall, hammering with its head and resting momentarily at the surface. A finger tap on the glass frightens it into the twilight of an algal mass, with a hind wing untidily lapped over one of the upper pair.

April 6, 1:30 p. m. A female *Ramphocorixa* is busily feeding in the sunlight, and is quickly buried in the ooze to its belly, bobbing and twirling the palae. The bobbing involves a vigorous dipping of the body with flirts of the swimming legs, and is characteristic both feeding and at rest. The timing now is about one flip of the legs per $\frac{2}{3}$ second. The movement may be even more rapid and energetic in feeding individuals, the hind legs flipping back and forth in unison, or alternating. Often a series of swift kicks are given on one side, the other leg pointing out from the body with a slight twitching.

A tiny corixid nymph stirs the ooze beside the female. Almost hyaline, this baby bug is as efficient in its movements as the adult, many times larger. Striped ostracods, the size of the youngster's head, glide by. Neither of the feeders pays any attention to them; they are rapt in their meal of microorganisms. A planarian snakes across the ooze, bumps into some obstruction, recoils violently, and glides smoothly away into the algae, leaving a sinuous path.

2:45 p. m. The sunlight has passed from the aquarium, and a female corixid feeds in the twilight near the glass. The swimming legs are extended laterally, with scarcely a single quick flip per minute. Bobbing movements are more frequent, seemingly induced by the middle pair of legs which are deeply anchored.

Often *Ramphocorixa* brings forward a hind leg and scratches furiously about its head, much like a dog with an offending itch. Similar action may be at the posterior end of the body, or along the sides and back. Sometimes there is an energetic digging about the eye, while the head rolls irritably; the nymphs frequently scrub the head with the palae.

An early instar is feeding eagerly, bobbing often and shuttling the palae over the beak. A water tiger passes perilously close to the nymph, but neither shows recognition of the other's presence, and the expected tragedy does not occur.

April 7, 9:40 a. m. Two female *Ramphocorixa* are feeding in a

corner next the window, raising a cloud of ooze. A snail, plowing along the bottom, shoves against the posterior of a corixid which flurries up through the water, returning just behind the snail. The other female approaches, and the two feed amicably together, occasionally touching; they soon separate.

A pygmy corixid nymph feeding nearby makes the characteristic dipping movements, but flirts the swimming legs infrequently. The air film over the body is proportionally less than on the adults.

1:30 p. m. The nymph is feeding in the sunlight next the window, in company with several adult females. Now, with every dip of the body, the hind legs are flipped back on each side. The energy of the tiny bug is amazing; it works without pause, and when not feeding makes short, scuttling dashes—all legs going at once—on an inspection tour up along the glass wall, or into a filmy mass of *Spirogyra*.

In contrast with the vigorous grubbing of the nymph, the adults nearby are quiet in the sunlight. One hangs motionless in an algal mass; the others rest on the bottom with occasional brisk movements of the forelegs. The corixids rise infrequently to the surface; individuals have been under observation on the bottom for more than half an hour. Bubbles rise constantly from *Vallisneria*.

3:00 p. m. For fifteen minutes a water tiger has attempted to capture one of several *Ramphocorixa* feeding in the early twilight of the aquarium. The sinister larva moves rapidly along the bottom, or over an algal mass, on its stout legs, but slows to a deadly, creeping movement when a length away from the corixid. Usually it approaches alongside the bug from behind, turns slowly in until its mandibles are almost touching, and then snaps viciously. Just before the bite goes home, the corixid moves enough to avoid it, and resumes feeding; while the water tiger remains posed for a moment in seeming disappointment. Finally it stalks on, dragging its heavy tail, poking into every hollow, and snapping impartially at whatever it may encounter.

April 8, 1:45 p. m. In the sunlight, two female *Ramphocorixa* and several nymphs are feeding in a depression. This hollow, an inch across and an eighth as deep, has been recently excavated in the smooth aquarium floor, resembling a miniature volcanic crater. With vigorous sweeping of the hind legs, the adults hurl aloft the silt and debris. In this they are undisturbed by a snail descending into the crater.

June 18, 8:30 p. m. Within the aquarium, indirectly lighted with a shaded bulb, a small crayfish has emerged from its den and forages

in the shrubbery of algae and eel-grass. The antennae lash about, the eyes bulge inquisitively. The cruising to and fro of the corixids often brings one in front of the crayfish, which grasps eagerly at the elusive bugs with big tweezers and small. These attempts seem clumsy, but several of the corixids are devoured in the night. As observed, the water boatmen frequently appear unconcerned by the slow approach of predatory menaces, and it is certain that Fate does not always play with them against their enemies.

MATING

June 16, 11:25 a. m. A male attaches itself to a female before the microscope. The end of the male abdomen is thrust out, twisted about and down to the left, curving in and around to join with the female genital apparatus. The male holds closely to the back of the female, clinging with the forelimbs (the palae grasping the margins of the female upper wings near the bases) and the genital arrangements. The prominent cephalic keel lies with its apex on the posterior margin of the female pronotum. The whole body of the male, excepting the wings, appears curved in the lateral view. Both sexes hold the wings in normal position. The activity of the female during the first half hour contrasts with the patient quietude of the male. An occasional flirt of the swimming legs, thrust out to the sides, and slight trembling of the posterior are the only movements of the male. The head is tucked down, so that large silvery air bubbles mark the junctures of the pronotum with the head and scutellum.

The female feeds almost constantly during the first half-hour, moving rapidly here and there, but with intermittent cessation of all movement except occasional beats of the hind legs. The clinging legs of the male drape loosely backward, past the abdominal tip of its mate.

Five minutes after attachment, the female ascends to the surface and returns instantly. In the last ten minutes, it ceases feeding, though continuing its darting movements on the bottom. Finally the female swims upward among the leaves of ell-grass, separation occurring at 12:05, about four inches from the bottom. The male immediately returns to the bottom; the female rests for a moment on a strip of *Vallisneria*, and then swims down. Eggs have been laid in the aquarium June 14 and several days following.

August 25, 11:30 a. m. A male and female are in copula before the lens, the position as described. The male is also flirting the swimming legs, often in unison with the female. The latter bobs

and feeds actively, frequently changing position, and once making a quick trip to the surface. Presently the two remain motionless for a minute or more, undisturbed by the presence of another female which alights upon the back of the male where it clings for a moment.

Eggs have been laid in the aquarium through the past forty-eight hours. The transparency of the corixid cuticula reveals the dim outlines of the eggs in the females, as well as other internal structures in adults and nymphs. It is possible to determine with a hand-lens in the field when the females are about to lay; when they are well-packed with eggs, oviposition usually occurs within a few hours and through several days following entrance in the aquarium.

OVIPOSITION

August 23. Numerous adults and nymphs (3rd, 4th and 5th instars) of *Ramphocorixa acuminata* have been collected from the shallows of a typical pasture pond (9:00-10:00 a. m., 78° F.). Placed in the balanced aquarium (10:45 a. m., 80° F.), they swim about and bob on the bottom. The vigorous dipping of the body is not necessarily accompanied by feeding, but most of the corixids are soon stirring the ooze with twirling palae. A small red flowerpot is sunken in the middle of the aquarium, and several corixids feed in the shadow of the rim.

11:30 a. m. A female before the microscope lays two eggs on the vertical rim of the clay pot. The corixid clings with the middle legs in the shadow, horizontal and facing west. It is motionless for several minutes, then flips the swimming legs rapidly and makes adjusting motions with these at the tip of the abdomen. The abdominal apex is then pressed against the smooth surface of the pot with a brief smearing movement, the apical plates spreading conspicuously. The abdomen lifts with trembling, swaying motions, and the egg slips out smoothly, erect on its pedestal, with the incurved (dorsal) side toward the female. Within the next minute, the corixid hops with quick flirting of the swimming legs and adjusting movements at the abdominal apex to a new position about one-fourth inch to the west, where another egg is deposited, precisely as before.

Meanwhile, three eggs are laid by another female an inch to the east, facing in that direction; and five eggs are placed on a runner of *Vallisneria*. All eggs are within an inch from the bottom and bend in all directions.

12:10 p. m. A female oviposits on a leaf of *Vallisneria*, facing up on the shadowed side, about two inches from the bottom. Again, there are quick flirting movements and adjustment of the abdominal apex by the swimming legs, and trembling, swaying motions of the abdomen with deposition of the egg. In all cases observed, the egg slips out in one or two seconds after these characteristic motions begin.

Within the next twenty-four hours, numerous eggs are deposited on *Vallisneria*, the rim of the flowerpot, and the glass wall of the aquarium. Many corixids of both sexes have perched without oviposition on the limbs, rostrum, carapace and telson of two crayfish fastened (footnote, p. 274) in the aquarium for several hours.

PART 3—THE SKELETAL STRUCTURE OF THE WATER BOATMAN

"The simplest and most satisfactory explanation that can be given. . . . A morphological interpretation cannot be fully acceptable unless it is consistent in all its implications."—Snodgrass (1938).

It is surprising to find how few and brief have been the morphologic studies of Corixidae—a familiar, widely distributed family of water bugs with remarkable structural adaptations. The attractive features of the group have been well recognized, but expressed for the most part in taxonomic and ecologic studies possible with a minimum of morphologic interpretations. Yet few insect groups offer opportunity for more convincing observations and absorbing reflections on the extensive remodeling of a generalized structural plan, correlative with the requirements of a special way of life.

Extreme specialization, characteristic among Hemiptera, does present difficulties in homologizing with more generalized orders. The works of Crampton, Weber and Snodgrass are most significant and encouraging in pointing out fundamental relationships, the structural clues which facilitate this task.

Based largely on the principles discussed by these authors, this introductory study will attempt descriptive identification of skeletal areas in *Ramphocorixa acuminata*. Though small, this corixid is an attractive subject with clear integument and unelaborate coloration. Some attention has been given to species of *Arctocorixa*, *Corisella* and *Trichocorixa*. The larger of these have been welcome comparative material, lending definition to parts obscure in the smaller species. Comparisons with more generalized hemipterans are given in the discussions of suggested homologies.

The head of Corixidae has received most of the morphological consideration given this Family. Usually discussions have centered on the curious beak (rostrum). Rösel (1755), Latreille (an 5 de la R.1), and Lamarck (1835) noted the peculiarities of this structure. Detailed studies of the mouthparts were made by Geise (1883), Börner (1904), and Hungerford (1919)—continued by Poisson and Jaczewski (1928), Ekblom (1930). Hansen (1930) and others. The beak has been discussed briefly in the several accounts of the food-getting habits and stridulation. Studies of the latter have been summarized by Butler (1923) and Mitis (1935). Aspects of face, vertex, pronotum, elytra, palae (fore tarsi) and genitalia commonly appear in taxonomic papers. Other representative writings are by Mecznikow (1866) on the embryology; Hagemann (1910) on the tympanal organ; Bedau (1911) on the compound eye; Rousseau (1921) on the nymphal structure; Brindley (1929) on the repugnatorial glands; Singh-Pruthi (1925) and Larsen (1938) on the genitalia; Elson (1937) and Spooner (1938) on phylogenetic comparisons; Banks (1939a) on the cephalic glands; and the sections on Corixidae in the general works of Schröder (1925, 1928, 1929), Weber (1930, 1933), Karny (1934) and Beier (1938)—all excellent digests of contributions of interest and value on structural details.

A full morphologic study of a representative corixid has not been completed. It is hoped that the pages following may contribute some measure of basic information toward that end.

THE CEPHALIC SKELETON

In the lateral view, the large corixid head is compressed in an opisthognathous caplike position on the prothorax. This conspicuous overlapping feature was considered by Crampton (1921), together with other resemblances in the head capsules (1932), to be indicative of the relationship of corixids and other hemipterans to the Psocidae. In the anterior view, the head is distinctly triangular, with the large compound eyes occupying the dorsolateral angles and thus the greater part of the width (Figs. 18, 21). In those species examined, the length and width of the head are approximately the same—nearly equal to the width, and about one-third the length, of the body (Table VIII).

The males of all species examined are smaller than the females, and the heads are proportionally reduced. The lateral borders of the male heads curve in more sharply below the eyes, so that the face appears narrower. It is also flattened or depressed in contrast with the tumid face of the females. The male vertex seems more

TABLE VIII. Measurements of representative Corixidae *

SPECIES.	Lengths.		Widths.		
	Head.	Body.	Head.	Body.	Between eyes.
<i>Aretocorixa scabricula</i>	3.8 mm.	11.4 mm. ^f	3.8 mm.	4.7 mm.	1.4 mm.
<i>Aretocorixa</i> sp.	3.2 mm.	10.1 mm.	3.3 mm.	4.0 mm.	1.2 mm.
<i>Corisella edulis</i>	2.4 mm.	8.3 mm.	2.5 mm.	2.9 mm.	1.1 mm.
<i>Aretocorixa alternata</i>	1.8 mm.	6.6 mm.	2.0 mm.	2.1 mm.	.7 mm.
<i>Ramphocorixa acuminata</i>	1.8 mm.	6.3 mm.	1.8 mm.	2.0 mm.	.7 mm.
<i>Trichocorixa</i> sp.	1.5 mm.	5.3 mm.	1.5 mm.	1.6 mm.	.6 mm.

* Female specimens. Limitations of ocular micrometer = 0.3 mm. at 42.5x. Lengths—head, in lateral view, from vertex to tip of rostrum; body, from anterior margin of head to tip of abdomen. Widths—head, across frontal region, between lateral angles of eyes; body, across widest portion of abdomen, excluding wing edges; between eyes, across narrowest portion between inner facial angles.

elevated above the level of the eyes; in *Ramphocorixa* this elevation culminates in a sharp point. The most evident sexual dimorphism is shown by *Ramphocorixa acuminata*, the females having even contour across the eyes and the vertex (Fig. 21). The males have the prominent specific character of sharply acuminate heads (Figs. 17, 18). The anterior surface of the vertexal point is flattened; the posterior surface bears a "keel." The acuminations are much reduced in *Ramphocorixa rotundocephala* Hungerford (1927), but a small point remains as an indication that this peculiar dimorphic condition of the head is characteristic of the genus.

The greatly expanded corixid vertex (Figs. 20, 21, Vx) is formed by the dorsal junction of the parietals, or lateral cranial areas, at the median coronal suture which shows in the nymphal head (Fig. 8, cs). The parietals, bearing the compound eyes and antennae, flank the facial frontoclypeal and paraclypeal areas (Fig. 21, Fr, Clp, PrClp) and the occipital areas and foramen (Fig. 19, Oc, For) on the posterior surface, where the suboccipital bridge (Soc) completes the cranial rim uniting with the rostrum (Ro).

The association of oral appendages in Corixidae has been considered of major taxonomic importance in its peculiarities—Börner (1904) assigned the Corixidae to the Suborder Sandaliorhyncha with especial reference to the rostrum. Among Insecta the labrum is essentially procephalic, a cranial prestomal flap (Leveraault, 1936), though commonly treated with the mouthparts which are properly gnathocephalic. In Corixidae, and other Hemiptera, the mandibular and maxillary plates and the basal portions of the labium also fuse into the cranial wall. The apical portions of the labium form the

rostrum (Figs. 19-21, Ro)—a small cup surrounding the labrum, the distal parts of the mandibular and maxillary stylets and plates, and the hypopharynx.

The details of the head skeleton may be discussed conveniently in two major divisions—the Cranium and the Rostrum, with associated ingestive structures.

THE CRANIUM

Frontoclypeal Areas. Two parallel vertical lines partially divide the ventral facial region into approximate thirds (Fig. 21, pcs). The lines are dorsal continuations of lateral sinuate horizontal inflections and end abruptly in the middle facial region. In cleared or dissected heads, a curved bar (Fig. 25, h) appears connecting the end point of each surface groove with the corresponding side of the masticating chamber (Mr) just above the sucking pump (Pmp).

The rostrum is easily removed from heads cleared of muscles and softened with caustic potash (or soda). This exposes the small pointed labrum (Fig. 25, Lm), fused dorsally with the clypeus. The bulky inverted T of the clypeus may then be lifted free, parting from the head along the sinuate horizontal lines to the dorsal extremities of the vertical lines. It is apparent that these lines represent the adjunction of two walls, the inner clypeal overlying the inflections of the lateral head walls. The curved dorsal bars are the dorsolateral junctions of these walls which extend into the sucking pump and are hinged proximally to work upon one another in the action of that food passage.

The frons (Fig. 21, Fr) is fused with the dorsal clypeal area between the end points of the vertical lines. In general, this relation, and the identity of the clypeus (Clp), may be established by examination of the attached muscles.* These are in three overlapping groups (Fig. 22, dlcb, dlbc, dlphy). The ventral group (dlcb) extends from the area bounded by the vertical lines, and just below, to the anterior wall of the sucking pump (Pmp). This typical hemipteran food tube is described by Snodgrass as derived from the cibarial passage of the primitive insect head. The muscles activating the pump are the cibarial dilators which attach on the clypeus. The corixid clypeus is unique (Spooner, 1938) in the hollow lateral extensions, overlapping ventral inflections of the paraclypeal areas (mandibular plates, p. 303). These extensions, and a part of the ventromedian clypeal area, represent the ante-clypeus (tylus) of other Hemiptera.

* Heads may be cleared and studied in thyme oil or xylol, with allowances for muscle shrinkage. These studies are supplemented advantageously with thick sections cut in celloidin.

The vertical lines do not arch upward and join on the median face, as often figured. Such an arch *seems* indicated by differences in surface elevation where the two dorsal groups of muscles (Fig. 22, dlbc, dlphy) are attached. These muscles extend inward to the masticator (Mr; Geise's kaukästchen, 1883) which is evidently derived from buccal and pharyngeal regions of the stomodaeum. The position of the frontal ganglion (FrGng) and its connectives clearly places one set of muscles (dlbc) with the ventral series, representing buccal dilators attaching on the clypeus. The frontal ganglion connectives loop back around the remaining set (dlphy), and these muscles are therefore pharyngeal dilators attaching on the frons.

Lacking the epistomal suture, the distinction of frons and clypeus is at best artificial. However, while the defining muscles in the corixid overlap in the lateral view, from the front they are separable, the thick pair from the pharynx forming dorsolateral crescents above the others. Defined strictly by the pharyngeal dilators, the frons would be limited to the area marked by these crescents; but there is probably an indeterminate dorsomedian extension. The frons has been considered to include the space between the compound eyes, separated from the vertex by "epicranial arms" (Spooner, 1938) apparent in the nymph. This opinion is convenient, but inconsistent with the relations of ocelli (*Diaprepocorinae*), compound eyes and antennae to these sutures.

Parietal Areas. The position of the epicranial suture—that is, the persistent molting line—is clearly indicated on the nymphal vertex. The mesal, or coronal, line (Fig. 8, cs) branches into definite sutures (pfs) extending ventrad along the inner margins destined to be reached by the compound eyes of the adult. The outlines of the adult eyes are plain in cleared nymphal heads (5th instar), with the characteristic inner border of setae mesad of the epicranial branches. The sutures are well separated from the nymphal eyes, curving around the inner ventral corners and down to the head rim above the antennae. The downcurve below the eyes remains in the adult (Fig. 21, hos) along the facial edge of an interesting strut (p. 304) setting off small triangular hypocular areas; the rest of the suture disappears.

Corixine nymphs show rudiments of latero-dorsal ocelli beneath the cuticula (Fig. 8, o) in the position found in the adult *Diaprepocorinae* (Fig. 10). These structures are definitely ventral to the epicranial fork. In the generalized head, ocelli are typically post-frontal in position. The excellent series of hemipteran heads figured

by Spooner (1938) often shows the "epicranial arms" posterior to the ocelli and extending laterad of the antennae; by extension of the sutures around the corixid head rim (Figs. 19, 21, hos), a like condition is suggested. True frontal sutures must pass mesad of the antennae toward the mandibular articulation (mda).

In view of the available evidence, the epicranial branches in the corixid nymph are probably postfrontal sutures without boundary significance. Frons and vertex merge indistinguishably, unless the attachments of pharyngeal dilators are considered limiting. The vertex probably includes the whole expanded upper portion between and behind the compound eyes, representing the dorsal junction of the cranial halves, or parietals. Inner membranous structures also suggest this condition. Visible through the cuticula and forming an apparent mesal line, membranes in connection with the aortic sinus partially divide the shallow cavity of the head above the dilator muscles into two lateral compartments. Within these lie the apices of the large cephalic, or maxillary, glands.*

Four rows of setae are regularly present on the vertex, two bordering the inner margins of the eyes, two near the mesal line (Fig. 4). These extend into irregular groups of setae below the eyes and on the vertexal margin above the occipital aspect. The inflections surrounding the eyes do not set off ocular sclerites; the clear marginal facets are misleading. Levereault (1937) has discussed this "optical illusion."

The paraclypeals (Fig. 21, PrClp) of Hemiptera have been termed the juga or lora, and homologized with the mandibular plates of Homoptera and postclypeal or genal areas. The developmental studies of Heymons (1899) gave impetus to the former opinion, and those of Muir and Kershaw (1911, 1912) to the latter. The controversial history was traced briefly by Hamilton (1931) and Spooner (1938), who presented a series of head capsules to indicate progressive development of the paraclypeal areas from the postclypeus. Snodgrass (1938) showed their derivation from the mandibular plates. In the corixid, the lateral extensions of the clypeus overlap ventral inflections of the paraclypeals which give attachment to protractor muscles from the mandibular levers (p. 309). The inflected portions are evidently mandibular plates, as shown by the muscle connections and the articulations with the levers (Figs. 19, 21, mda). The uninflected paraclypeal areas fuse with the lower parietals, or genae (Figs. 19-21, Ge), below the compound eyes.

* Described in the Corixidae by Elson (1937) and Banks (1939); in *Belostoma* by Loey (1884); in *Notonecta* by Bordas (1906); in *Nepa* by Bordas, and Hamilton (1931). Poisson (1924) mentions maxillary glands in corixids, notonectids and naucorids.

The parietals on the posterior surface include the expanded vertex (Fig. 19, Vx) above the occipital foramen and the ventrolateral areas (Ge) bearing the antennae. The vertexal surface is concave, fitting over the prothorax. In the nymph, it is halved by the coronal suture, continued from the facial surface. The mesal suture is marked in the adult by a persistent indentation between converging groups of setae on the head rim behind the eyes. The cuticula is generally thickened in the deep concavity of the vertex where it impinges on the rounded anterior surface of the prothorax. The dilator muscles of the postpharyngeal expansion of the alimentary canal (Fig. 22, dlpphy) attach on the vertex just above the occipital foramen, and the retractors of mandibular and maxillary stylets attach in the vicinity laterad.

The lower parietals, or genae (Fig. 19, Ge), bear short, four-segmented antennae (Ant). The antennal socket (Fig. 26, As) is oval and tilted up toward the head rim. The antennifer is represented by an inner dorsal thickening on the marginal inflection. The scape (Scp) is longer than the pedicel (Pdc) and curved upward. The third segment, or first segment of the flagellum (Fl), is club-shaped, and as long as the first two segments; the apical segment is awl-shaped and shorter. Only the basal segments are distinct in the nymph.

The upper and lower parietals are partially separated in the occipital aspect by an inflection slanting down from below the eye (where the postfrontal inflection of the facial surface intersects the head rim) to a position above the antennal socket (Fig. 19, hos). Within the angle of the converging lateral head walls, the anterior and posterior inflections are continuous, forming a sturdy hypocular strut (Fig. 26, Hos). The derivation of this structure may be demonstrated in heads cleared and softened with caustic potash. The lower area shielding the antenna easily separates along the double-walled inflection as a fenderlike extension of the gena, fused dorsally with the in-turning cranial wall below the eye to form the hypocular strut.

Occipital Areas. The true occiput of the generalized insect head arches over the occipital foramen between the occipital and post-occipital sutures. In the frequent absence of the former suture, the occipital arch is rarely well-defined and is often considered synonymous with the posterior cranium. In Hemiptera, and other orders, the arch is sometimes lost in the encroaching parietals. The ventral occiput, or postgenae, of Corixidae (Figs. 19, 20, Oc) fuses

dorsally with the vertex and the postoccipital rim beside the foramen; laterally with the genae; and ventrally enters into the surficial maxillary plates (Mxpl) and the suboccipital bridge (Soc) below the foramen. The lateral (anterior) limits may be indicated by a line drawn from the dorsal postocciput to the mandibular articulation (mda). Below this point the cephalic gland opens (cgo) on the margin of the maxillary plate next the lateral extension of the clypeus (Clp) overlapping the head rim below the gena. The plates and the suboccipital bridge are considered in the discussion of ingestive appendages (pp. 306-308).

The Postocciput (Fig. 19, Poc). The postoccipital rim surrounds the ovate occipital foramen, or foramen magnum (For), fitting closely into the anterior hollow of the prothorax. A dorsal ledge (r) receives muscles from the mesothoracic phragma (Fig. 41, 1Ph), and prothoracic muscles attach upon lateral processes of the rim (Figs. 19, 20, pr). These muscles vigorously activate the head in feeding and use of the air supply. Similar muscle attachments upon the cervical sclerites of the generalized insect head may suggest the derivation of the lateral processes. The corixid cervix is reduced to the short membranous tube joining the head directly to the prothorax; ventrolateral thickenings of the postoccipital rim (cva) meet in extrinsic articulation with ventral prolongations of the prothoracic episterna (Fig. 35, cva).

THE ROSTRUM AND INGESTIVE STRUCTURES

The Labium. The corixid beak, or rostrum (Figs. 19-21, Ro), is formed by the pyramidal labium (Fig. 22, Lb), overlapping the labrum (Lm) and thus enclosing the apical hypopharynx and distal mandibular and maxillary parts. (The development of this relationship was described by Mecznikow, 1866.) The labium is broadened in union with the suboccipital bridge, the external maxillary plates and the ventral ledge of the clypeus. The posterior surface contour of the subocciput continues on the labium—a broad mesal elevation sloping to the lateral margins. The anterior, or facial, surface is evenly curved and transversely grooved, with a mesal indentation where the lateral areas adjoin (Fig. 34). This line of fusion is interrupted at the rostral tip by the oral apparatus (lbo).

The lateral margins of clypeus and rostrum are heavily bearded (Figs. 17-21). The long anterior setae thrust downward; the posterior thrust outward, and a line of finer setae parallels the rostral margin. On the apical posterior surface, the mesal elevation is tipped with a long goatee and immediately truncated. The triangu-

lar face of the truncation is distinct from the oval tip of the anterior surface pierced by the oral opening (Figs. 20, 21, lbo). Lateral fans of short setae project across the lower bulbous surface of this area (Fig. 34). The rostral setae are probably of service in combing and sifting food organisms from the twirling palae (p. 320).

The extended labium of the hemipteran beak has long challenged researchers in its relations to the generalized type (Geise, 1883; Wedde, 1885; Leon, 1887; Smith, 1892; Marlatt, 1895; Heymons, 1899; Muir and Kershaw, 1911; Bugnion and Popoff, 1911; Tower, 1914; Snodgrass, 1927, 1938; Weber, 1928; et al.). The interesting historical accounts of Leon and Weber are particularly recommended. In summary it may be noted that Crampton (1928, cf. 1929) figured a series of modifications through several orders to show derivation of the apical segments from fused labial palpi and palpigers, supported by the basal mentum attached to the suboccipital gula.

In turn, the corixid rostrum is oddly modified from the usual hemipteran condition in its segmental and suboccipital relations. Comparison with *Notonecta* shows proportional broadening and shortening of the apical labium, and fusion of the posterior basal portion with the subocciput. The probable dorsal boundary in this region may be indicated by lines drawn between the cephalic gland openings (Fig. 19, cgo) and the transverse median groove (g). The true suboccipital bridge (Soc), including the median gular area and lateral extensions inward from the lower occipital areas, must lie above the groove. Attached within is a curious median shaft (Fig. 22, 24, Lbs) slanting forward to unite with the anteromesal labial wall (the invaginated floor of the inner labial cylinder) near the apex of the hypopharynx (Hphy). The shaft has been considered a tentorial structure (Börner, 1904); another view of its derivation and some insight on segmental relations may be given by comparing median sagittal sections of corixid and notonectid heads (Figs. 22, 23).

In *Notonecta* (Fig. 23), the long, four-segmented labium (Lb 1-4) forms a piercing beak. The sides curve forward, enclosing the mandibular and maxillary stylets in a deep groove, covered by the labrum (Lm) in the basal segment and sealed over in the apical three segments. Where the stylets enter the sealed-over channel (Lbcy) in segment two, a broad median shaft (Lbs) from the anterior labial wall slants in toward the posterior basal edge of the labium within the subocciput (Soc.). Four median groups of muscles on the shaft

—two (Mcl A, B) attaching on the posterior basal edge of segment three, two (Mcl C, D) attaching on the median anterior wall of segment one—serve with others in the movements of the apical labium. The salivary meatus (sm), or exit duct, enters from the syringe (Syr) between the tip of the hypopharynx (Hphy) and the anterior mesal groove in the basal labial segment.

In the corixid (Fig. 22), the apical segments of the labium form a rostral cup thrust back upon the cranium covering the apical hypopharynx (Hphy) and the labrum (Lm) to the margin of the clypeus (Clp). The apexes of the mandibular and maxillary stylets pass between the inner labial and lateral hypopharyngeal walls. Where the stylets converge and enter the short cylinder (Lbcy) leading to the orifice (lbo), the median shaft (Lbs) from the anterior labial wall slants in to unite with the subocciput (Soc) just above the transverse median groove (g). Two groups of muscles on the shaft attach (Mcl A) below and (Mcl B) above a short transverse ridge (Lb_{sb}) within the posterior median wall of the rostrum.

Thus comparison of the corixid with the notonectid suggests the derivation of the median shaft (Fig. 22, Lbs) within the labium as an apodeme from the anterior wall at the junction of segments one and two. The two posterior groups of muscles (Mcl A, B) on the shaft, if homologous, are reversed proportionally when compared with the notonectid, but retain the same general relations to the inner basal ridge of segment three, though the ventral group (Mcl A) spreads considerably from this point. The anterior muscles on the apodeme in the notonectid labium (Fig. 23, Mcl C, D) are absent from the corixid, the shaft (Fig. 24, Lbs) fusing solidly (at) with the anterior labial wall (Lb) behind the apex of the hypopharynx (Hphy). The thrust of the apodeme into the cranium carries it beyond the salivary syringe (Fig. 22, Syr), though the salivary meatus (sm) is much elongated between the hypopharynx and the labial wall. Small muscles join the lateral hypopharyngeal processes (Fig. 29, pr) and the ends of the transverse median groove (Fig. 24, g) in the subocciput. These connections suggest the larger muscles which join the hypopharyngeal processes and the posterior basal ridge of the second labial segment in the notonectid.

Consistent with the indicated segmental homologies are the relations of the corixid labium and the maxillary plates (discussed below), and the mechanism of the rostral apex. The bulbous circumoral area (Fig. 34) bears an interesting arrangement of sclerotic bars (br). The lateral angle of the upper triangular figure on either

side of the orifice (lbo) is connected by muscles (dlbo) to the dorsal posterior corner of the rostrum; contraction of the muscles widens the opening (Hungerford, 1919). The counter movement is induced by the elasticity of the cuticula, assisted by muscles (Fig. 33, olbcy) reaching from the posterior labial wall, beside the median muscles from the labial shaft, to sclerotizations of floor and wall of the apical labial cylinder (Lbcy). The muscles of the inner cylinder and its orifice, controlling the passage for the mandibular and maxillary stylets, are significantly like those with similar function in the distal third segment of the notonectid labium.

Maxillary and Mandibular Parts. In the backswimmer, the lateral openings of the cephalic, or maxillary, glands are found on the posterior boundaries of the maxillary plates. The anterior borders of the plates are inflected beneath the clypeus, continuing along the basal anterior labial wall into the hypopharyngeal processes on either side of the salivary syringe. The protractor muscles of the maxillary stylets attach on the inflected portions of the plates in pouches formed by folds over the maxillary and mandibular stylets against the lateral hypopharyngeal walls. (See Heymons, 1899, and Butt, 1943.)

In the water boatman (Fig. 19), the same general relationships are found, though the maxillary plates (Mxpl) are almost wholly inflected beneath the lateral extensions of the clypeus (Clp) anterior to the cephalic gland openings (cgo). The plates taper toward the middle (Fig. 29) into little more than marginal thickenings on the basal anterior labial wall and the attenuated hypopharyngeal processes (pr). The protractor muscles of the maxillary stylets (pmx) attach on these margins.

The maxillary and mandibular stylets, or bristles, of Corixidae are shorter and less closely bound together than usual in Hemiptera. From the extremities, commonly showing in the rostral orifice, the two pairs of stylets (Fig. 29, MxS, MdS) may be traced through the apical labial cylinder and into the cranium on either side of the hypopharynx, in the space between the basal anterior labial wall (Lb) with the attached inflected portions of the maxillary plates (Mxpl), and the lateral hypopharyngeal walls with the attached inflected portions of the mandibular plates (Mdpl). The retractor muscles (rmx, rmd) of the stylets attach on vertexal areas laterad of the dorsal postoccipital rim.

The maxillary stylets (the inner pair) show apical differences. The right stylet (Fig. 30) is broad-bladed, with the inner surface

hollowed; the left (Figs. 31, 32) seems curiously twisted, with a flap of the anterior edge over the deeply hollowed inner surface. When the two apices, freely movable on one another, are thrust out together, the hollow of the right claps over the twisted left, forming a tube. This may serve in sucking, or working, material into the sucking pump, and may receive the secretion from the salivary syringe. Food and salivary canals, found in the fascicle of stylets in other Hemiptera, are not differentiated in Corixidae (Geise, 1883; Börner, 1904; Weber, 1930; Elson, 1937; et al.). The tips of the maxillary stylets are roughened and may serve in rasping and prehension.

The mandibular stylets (the outer pair, Figs. 27, 28) are of more purpose in piercing and holding organisms (as observed by Geise, 1883). These instruments are apically similar, spear-like and armed with several anterior teeth sloping proximad, and probably have a shuttle-like action in securing food and scraping it into the functional mouth. The cranial attachments emphasize the suggestion of implemental activity and power. Each stylet is united to a triangular mandibular lever (Fig. 27, mdl) at the mesal angle (Fig. 28, m); a sclerotic bar extends from this point up into the dorsal angle (d) and down into the lateral angle (l) where it forks into anterior and posterior articulations (Fig. 27, ca) with the cranial wall (Figs. 19, 21, mda). Protractor muscles (Figs. 25, 29, pmd) attach on both surfaces and reach into the pouch formed by the inflected ventral paraclypeal area, the mandibular plate (Mdpl), which continues into the lateral hypopharyngeal wall (Snodgrass, 1938).

The Sucking Pump. The hemipteran sucking pump has been shown by Snodgrass to be derived from the cibarium (preoral cavity) of the generalized insect head. In the corixid (Fig. 22, Pmp), the inner surfaces of labrum (Lm), clypeus (Clp) and hypopharynx (Hphy) are involved. The true mouth (Mth) and pharynx (Phy) are deep within the cranium, the latter posterior to the frontal ganglion (FrGng). The terms epipharyngeal and hypopharyngeal, generally applied to the anterior and posterior surfaces of the sucking pump, hold over from authors identifying the structure with the pharynx.

The corixid labrum (Figs. 22, 24, Lm) is a snoutlike cranial projection within the rostral cup below the clypeus (Clp), fitting over the tonguelike apical hypopharynx (Hphy). The united sclerotic tips of labrum and hypopharynx form an opening from the apical

labial cylinder (Fig. 22, Lbcy) into the sucking pump (Pmp). The plunger of the pump is the inner (epipharyngeal) wall of labrum and clypeus, the latter activated by the usual cibarial dilators (dlcb). The cup, or sitophore (Snodgrass, 1938), of the pump is the hypopharyngeal wall. These walls hinge dorsally in lateral bars beside the entrance to the masticator (Mr). The pump sucks in material as the cibarial muscles lift the epipharyngeal plunger; the material is forced into the pharynx as the elastic plunger presses again into the hypopharyngeal cup, acting from the narrower distal to the wider proximal end joining the masticating chamber. Lateral epipharyngeal hairs slant toward this entrance, directing the material to the middle and preventing backflow.

The Masticator. The action of this unique grinder (Figs. 22, 25, 29, Mr) is similar to that of the sucking pump. Two groups of muscles pull out the forward wall of the sclerotic box, which snaps in again on relaxation of the dilators. The inner surfaces of the masticator are toothed and spined, indicating its function in the ingestion of the varied corixid diet (Geise, 1883; Börner, 1904; Poisson and Jaczewski, 1928; Weber, 1930; et al.). The organ does not appear in the liquid-feeding *Notonecta* (Fig. 23, Phy), where the sucking pump (Pmp) is strongly developed.

The corixid masticator (Fig. 22, Mr) is derived from the posterior cibarial, or buccal (Mth), and the anterior pharyngeal (Phy) regions, as indicated by the dilators. These muscles attach by two median tendons, and are separated by the frontal ganglion (FrGng) into prefrontal, or clypeal, and frontal series (p. 302). The foremost group (dlbc) probably represents the buccal dilators, acting upon the region of the true mouth; the posterior muscles (dlphy) are pharyngeal dilators. The posterior pharynx (Pphy) bends sharply horizontal, with dilators (dlpphy) attaching on the vertex and post-occipital rim above the occipital foramen, and continues into the slender tube of the esophagus (Es).

The Salivary Syringe. The apical hypopharynx (Fig. 22, Hphy) is hollow and tonguelike (the lingua, Snodgrass, 1938), thrust out over the basal anterior labial wall below the apical inner wall of the labrum. The anterior hypopharyngeal wall continues dorsad as the sitophore of the sucking pump; the posterior wall is united with the labial base where the marginal attenuations of the maxillary plates fuse into the hypopharyngeal processes (Fig. 29, pr). Between these thin extensions, the salivary syringe (Syr) is attached to the basal posterior hypopharyngeal wall. The structure is a small cylinder

fitted with a piston, dilator muscles (dlsyr) attaching on the hypopharyngeal wall of the sucking pump. When the cylinder is expanded by contraction of the dilators, the secretion of the salivary glands, located in the thorax over the esophagus, enters the posterior wall of the chamber through a pair of salivary ducts (Fig. 22, dct). The piston, snapping back into the cylinder, closes these ducts and forces the secretion out through the salivary meatus (sm). This tubule passes between the anterior and posterior hypopharyngeal walls to the apex. The secretion may then enter the hollow of the maxillary stylets within the inner labial cylinder (Lbcy).

THE THORACIC SKELETON

The thorax of Corixidae conforms smoothly to the streamlined plan of the body. With strong walls supporting the neat arrangement of inner struts and glistening muscles, the whole effect is of compactness and efficiency comparing favorably with the swift, graceful backswimmers.

The thoracic mechanism is chiefly remarkable for the advanced specialization of the appendages. These are fitted perfectly to the locomotor and ingestive requirements of active aquatic insects subsisting on ooze organisms. The forelegs are designed specifically for lading ooze, the middle legs for clinging, the hindlegs for swimming. Two well-developed pairs of wings are regularly present. (The hind wings are reduced in some Corixidae.)

The *prothorax* (Figs. 35-38) is closely attached to the head by the narrow membranous neck, and usually separates off with the head in dissection. The loose membranous connection with the mesothorax permits the variety of prothoracic movements incidental to ingestion and respiration. The wing-bearing segments (meso- and metathorax) are joined compactly as the *pterothorax* (Figs. 39-41), firmly united to the abdomen. The neck, or *cervix*, is fundamentally intersegmental (Crampton, 1917), though parts are probably derived from the labial and prothoracic segments (Snodgrass, 1935). It is discussed in this section as an introduction to the prothorax.

THE CERVIX

The corixid cervix (Fig. 42, Cvx) is the short, tubular intersegmental membrane joining the postoccipital rim of the head within the anterior hollow of the prothorax. The cervical wall encloses the dorsal shelf (Fig. 19, r) and lateral processes (pr) of the postocciput, surrounding the occipital foramen (For). Below the processes, the membrane passes to the inner margin of the rim, exposing the bul-

bous articular surfaces (cva) for extrinsic contact with similar episternal surfaces on the prothorax (Fig. 35, cva). The posterior cervical rim unites with tergal (T_1), episternal (Eps_1), precoxal ($Prcox$) and sternal (Stn_1) parts of the prothorax within the anterior hollow receiving the postoccipital elevation (Fig. 20, Poc).

The cervix is pleated and flexible; the condylar surfaces on the postocciput and episterna serve as fulcrum and buffers as the water boatman actively bends and rotates the head. The cervical (or juglar: Crampton, 1914) sclerites, hinging the condyles and prothorax in the generalized plan, are not apparent in Corixidae. (Absent also in *Corizus lateralis*: Davis, 1938.) Their absence may be explained by the presence of the lateral postoccipital processes (Figs. 19, 20, pr). These assist in the requisite functions of connection and activation by thrusting into the prothorax and providing attachment for protractor, retractor and rotator muscles. In turn, the derivation of the processes may relate to the absent cervical sclerites.

THE PROTHORAX

The prothoracic segment (Figs. 35-38) is reduced to the essentials of an active, ringlike support for the head and forelegs. This is particularly evident in the nymph (Fig. 8, T_1) lacking the dorsal scooplike extension of the pronotum (Fig. 42, T_1) over the mesothorax. In the adult corixid, the prothorax is capped by the dorsolaterally expanded head, and in turn fits closely over the anterior pterothorax. Since the wing bases conceal the metanotum, the pronotum is the only tergal portion of the thorax largely exposed in the resting position. (When the pronotum tilts forward in action, a posterior triangle of the mesonotum—the scutellum, Fig. 3, Scl_2 —is proportionally uncovered. The scutellum is characteristically exposed in the Micronectinae.) The dorsal cephalic portion of the prothorax enters the lateral walls, or pleura, which taper down to a narrow ventral bar, the sternum (Fig. 37, Stn_1), between the legs. The prothoracic segment is slanted in correlation with the opisthognathous head and the angle of the anterior pterothorax.

The Pronotum. The free caudal expansion of the pronotum is cross-striated with varyingly continuous light and dark bands, less definite in *Ramphocorixa* (Fig. 4) where sharply contrasting markings are not characteristic. The expansion is important as an air retainer and a protective shield, but represents only a secondary flap of the primarily important cephalic pronotum (Fig. 42, T_1) concealed by the expanded vertex (Vx). Here the dorsal intersegmental membrane ($Isgm$) attaches at the base of the pronotal

shield, and the dorsal prothoracic muscles fasten anterior to the membrane.

The exposed pronotal area may have a broadly rounded mesal elevation, with individual variance. The concealed cephalic area is halved by a mesal suture (Fig. 35, ms) with an internal ridge (Fig. 36, mr). The suture is continuous with the epicranial molting line in the nymph; the ridge provides additional surface for muscle attachment.

Pleural Areas. A deep groove (Fig. 38, pla) subdivides each lateral prothoracic wall above the limb base. The pleural apophysis (Fig. 36, PlA) rises from the inner ridge of the groove, arching above the coxal cavity to join a process of the sternal furca (fu). The ridge (plr) forks above the base of the apophysis, and continues below to the coxal articulation (Fig. 37, cx ap). Thus the groove, an inflection contributing to the pleural ridge and apophysis, is part of the pleural suture (Fig. 38, pls), separating the presutural episternum (Eps₁) from the postsutural epimeron (Epm₁) (Snodgrass, 1935). The pleural and the lateral tergal walls are continuous above the pleural sutures.

The episternum (Fig. 35, Eps₁) bounds the lateral rim of the prothoracic opening. The ventral part of the pleurite tapers abruptly into a narrow strip ending in the cervical articulation (cva). The ventral epimeron (Epm₁) forms a lobe (Fig. 37, Epm₁), continuous with the narrow postcoxale (Pcx) behind the coxal cavity. The lobe is separated by an indentation at the coxal articulation from the wide precoxale (Fig. 38, Prcx) which lies before the coxal cavity and below the ventral episternum. The precoxal and postcoxal bridges (Fig. 37, Prcx, Pcx) unite with the sternum (Stn₁).

The Prosternum. The ventral wall of the prothorax is concealed by the overlapping rostrum and the converging basal segments of the forelegs (Fig. 36, Cx, Tr). The sternum is reduced to a narrow sclerite (Fig. 37, Stn₁) between the coxal cavities, joined by the precoxal and postcoxal bridges (Prcx, Pcx). The sternal wall is tilted almost vertical by the extreme slant of the prothorax beneath the anterior pterothorax. A pair of lateral processes, the furca (Figs. 35-38, fu), thrusts up into the pterothoracic opening. Among the muscles attaching on the furca are those connecting it with a similar development of the mesosternum. Within the prothorax the pleural apophysis (Fig. 36, PlA) unites with the furca at the junction of the postcoxale (Pcx) and the outer sternal wall, forming the pleurosternal bridge (plst).

THE PTEROTHORAX

The wing-bearing thoracic segments show the expected alterations from the generalized condition in the stream-lining, compactness and specialization of appendages necessary to an underwater swimmer. The pleural chambers in which air may be locked by the wings are special developments of particular interest in the water boatman. The expanded pronotum and the wings largely conceal the broad tergal areas. The mesonotum (Fig. 42, T_2) humps over within the hollow of the prothorax, placing the intersegmental communication in a ventral position. The usual slant of the pleural areas, encroaching on the sternal, is correlatively exaggerated (Figs. 39, 41). In contrast with the extreme slope of the anterior pterothorax, the posterior is almost directly truncate in the broad junction with the abdomen.

Tergal Areas. The base of the intersegmental membrane on the anterior pterothorax is diamond-shaped, enclosing the large opening and a triangular phragma (Fig. 41, 1Ph). Muscles from the anterior (ventral) surface of the phragma attach on the inner pronotal wall and the dorsal postoccipital ridge (Fig. 19, r). Within the pterothorax, dorsal longitudinal muscles connect the much larger posterior phragma (Fig. 42, 2Ph) with the inner surfaces of the anterior phragma (1Ph) and the bulbous dorsal expansion of the anterior mesonotum (T_2). The posterior phragma descends from the antecostal suture (that is, as an extension of the antecosta, or intersegmental inflection), overlapped by a dorsal flange of the postnotum (Fig. 40, Pn₂). The mesonotal dome (T_2) is thus separated from the smaller metanotum (T_3), joined squarely with the first abdominal tergum. At this junction, the expected third phragma is missing from the antecosta (Fig. 42, I Ac). The condition is similar in notonectids.

With the concentration of the corixid locomotor mechanism in the pterothorax, the mesothoracic muscles are largely specialized in arrangement and proportion as wing activators; the metathoracic muscles are chiefly activators of the powerful swimming legs, though also serving the wings in flight. Wing movement (p. 322) depends largely on the flexing of tergal areas, acting on the wing bases (Fig. 39, W_2 , W_3) against the pleural wing processes (plw₂, plw₃). In correlation with the main locomotor function shown by the two segments of the pterothorax, the metanotum is the larger in the wingless nymphs, and the mesonotum becomes larger in the winged adults.

In the water bugs examined (*Ranatra*, *Belostoma*, *Notonecta*, *Buenoa* and corixids), a median and two lateral lines of flexure (Fig. 40, ms, no) are well established on the anterior mesonotum. The median suture is also the molting line in the nymphs. The lateral lines probably represent the notaulices, or parapsidal sutures, shown by Malouf (1932) in the stink bug. In the corixid, each notaulix (Fig. 41, no) is intersected by the mesal end of an incomplete transverse suture (ts). The prescutum (Prsc₂) is thus imperfectly separated from the scutum (Set₂). In this connection, it may be re-emphasized that the traditional thoracic tergal divisions seem generally more for the sake of reference than morphologically significant (Leverreault, 1936). The original dorsal divisions of the mesothorax given by Fieber (reviewed in Hagemann, 1910) were the "dorsulum," covered by the pronotum, and the "scutellum," more or less exposed.

Two additional pairs of flexure lines (Fig. 40, f, rvs) enter the corixid mesonotum. The posterior (rvs)—the clearest and most persistent, occurring also in the notonectids—possibly represents part of the absent scuto-scutellar suture, though more likely an intra-scutal reversed notal suture (Snodgrass, 1935). The corixid scutellum (Scl₂) is thus undefined anteriorly, but the posterior margin is always indicated by the inner extension of the axillary cord (Axc₂). This continues inward from the vannal (posterior) margin of the forewing along the deep V-shaped mesonotal groove (WG) which receives the inner postaxial margins of the flexed forewings. By prying up the mesal flange behind the groove (Pn₂), the inflected postnotum, the antecostal suture and the anterior wall of the metanotum are exposed. The flangelike development is the only uncovered part of the postnotum between the line of the axillary cord, or posterior boundary of the scutellum, and the intersegmental line, or antecostal suture.

The posterior phragma (Fig. 43, 2Ph) is an apically divided, anteriorly hollowed plate, braced by the lateral antecostae (Ac) and a contributory mesal inflection of the metanotum (mr). Excepting the suture of this ridge (Fig. 40, ms), the metanotum (T₃) is divided only by the line of the axillary cord (Axc₃), separating the fused scuto-scutellar region (Set-Scl₃) from the laterally distinct postnotum (Pn₃). The curvature of this boundary closely follows that of the anterior intersegmental line, carrying the base of the hindwing forward. The posterior antecostal suture (Fig. 43, acs), separating the postnotum from the first abdominal tergum (I T), is directly transverse and without a phragma on the antecosta (I Ac).

Pleural Areas. The pterothoracic pleura enter largely into the venter. The areas are primarily distinguished by reference to the pleural suture and its developments. The basic relations of this inflection have been indicated in the relatively simple prothorax (p. 313), there separating the presutural episternum and the postsutural epimeron, from the coxal articulation to the pleural apophysis. The latter joins the sternal apophysis (in the furca), forming the inner pleurosternal bridge (Fig. 37, plst) across the prothoracic coxal cavity bounded by the precoxal and postcoxal bridges (Prcox, Pcx). The pleural and sternal apophyses are not joined in this fashion in the pterothorax, and the circumcoxal bridges are fused into adjacent pleurosternal parts. The basic relationships are complicated by the special features of flight, air chambers and extreme tilting.

The mesothoracic pleural inflection (Figs. 39, 41, pls₂) runs forward on the lateral venter from the coxal articulation (Fig. 43, cx ap₂), curving abruptly upward along the anterior margin of the air chamber (Fig. 39, AC) and into the base of the pleural wing process (plw₂). The inflection is strongest in the upturn, with the stout pleural apophysis (Fig. 43, PLA₂) developed on the inner ridge and connected by short fibers to the attenuated sternal apophysis (that is, the anterior process of the furca, pr'). The mesothoracic episternum (Figs. 39, 41, Eps₂) is the sclerite anterior to the pleural suture. The narrow dorsal extension braces the pleural wing process behind an area variously flexible in the tergal movements activating the forewing. This area is probably derived from the prealar bridge between the prescutum and the episternum, as suggested by Malouf (in the stink bug, 1932). The ventral episternum (Fig. 41) is broad and imperfectly separated from the sternum by differences in surface level and an incomplete suture.

The mesothoracic epimeron (Figs. 39, 41, Epm₂), posterior to the pleural suture, is curiously altered to form the outer wall of an air chamber. The inner wall of this pocket under the forewing margin (Fig. 39, AC) is largely an extension of the lateral dorsum, bearing the spiracle and tympanal organ (Sp₂, Tymp; p. 318), plus an anterior inflection of the metathoracic episternum (Eps₃). These inner parts are overlapped by an epimeral flap (Fieber's "scapula") (Epm₂) with a small hook (h) attaching on an inflected marginal scroll (sl) of the folded forewing. The progressive development of the broad flap from the basically narrow epimeron may be traced in the nymphs.

The metathoracic pleural coxal process (Fig. 43, cx ap₃) is high in the posterior lateral wall, beside the enlarged coxal cavity. The

pleural suture (Fig. 39, pls₂) runs forward from the coxal articulation, diagonally through the length of a shallow extension of the air chamber beneath the forewing margin (AC'). The wing process (plw₂) lies above the anterior end of the pleural inflection, which continues (Fig. 43, plr₂) into the antecosta (Ac) without developing the typical pleural process.

The metathoracic episternum forms the lower wall of the hollow containing the pleural suture, and the posterior inner wall of the larger air chamber (Fig. 39, Eps₂). The broad external plate (Figs. 39, 41) narrows ventrally, with the mesal extremity fitting into the basal constriction of a spearlike sternal development (the metaxyphus, Fig. 41, Sl₂). The anterior ventral margin is overlapped by the mesothoracic epimeron and a flap of the sternum behind the mesocoxal cavity. Where these overlapping elements meet laterad of the cavity, the orifice of the scent gland (sgo)* shows in the intersegmental crevice, or "metacoxal groove."

The metathoracic epimeron (Fig. 39, Epm₂) forms the upper wall of the posterior air chamber (AC') and continues on the surface beneath the wing into the area posterior to the axillary cord (Axc₂). The dorsal part of this area must represent the postalar bridge from the postnotum (Pn₂) to the epimeron, as suggested by Malouf (in the stink bug, 1932). The posterior part of the area is continuous with an oddly shaped lobe (lbe). In the nymph, this is a simple lateral pouch beside the first abdominal tergum, though deriving also from the epimeral region; the tip of the pouch shelters the spiracle. In the adult, the hollow lobe communicates with the thorax, and is set off from the abdomen by an extension of the antecosta (Fig. 43, I Ac); the spiracle (Fig. 39, I Sp) opens within the membranous corner of the first abdominal tergum (Fig. 51), rounded by the antecostal inflection (acs). While definitely part of the adult thorax, the lobe serves as a supporting pleurosternite of the reduced first abdominal segment, articulating firmly with the tergal margin of the second.

The air chambers (Fig. 39, AC, AC') are particularly interesting developments of the pleural region, because of the arrangement of contributing parts, as described, and the spiracular and sensory connections. The large metathoracic spiracle (Sp₂) is in direct com-

* Hungerford, in Brindley (1929). Tower (1913) figured the orifice in a similar position in *Anasa tristis*, and Davis (1938) found "a pair of scent gland ostioles in the anterior pleural portions of the metathorax" in *Corisus lateralis*. Brindley described the glands of *Corisus*, with a brief summary of the work on other hemipterans, and a tabulation of the position of the nymphal glands in seventeen species, representing ten families. Variations in nymphal Lygaeidae were given by Usinger (1936). Note also the work of Guide (1902) and Krüger (1909).

munication with the other two major spiracles (Fig. 43, Sp₂, I Sp) by lateral tracheal trunks. The thoracic spiracles (Sp₂, Sp₃) are simple openings, probably chiefly inspiratory. The first abdominal spiracle (I Sp) opens out through a membranous cone, directed across the hollowed dorsal surface of the lateral lobe (Fig. 39, lbe). This pocket communicates with the space beneath the wings and with the exterior through a crevice between the lateral lobe and the tergal margin of the second abdominal segment beside the metacoxal cavity. The suggestion is that air is drawn through the anterior spiracles into the large thoracic tracheae and exhausted through the posterior spiracle, returning to the constant supply over the body. The circulation is probably aided by the hind limbs sweeping backward over the outer air film. The relation of the movement to the carbon dioxide tension has been discussed by Botjes (1932).†

The curious tympanal organ in association with the metathoracic spiracle (Fig. 39, Tymp) consists of a free, club-shaped portion arising from a heavy base resting on an oval membrane. The organ was studied by Hagemann (1910; quoted in Imms, 1925; Weber, 1930; and Beier, 1938). The freely moving club, the basal membrane and the nerve connections suggest the sensory functions of hearing and equilibration.

Sternal Areas. The true sternal parts on the broad under surface (Fig. 41, Stn₂, Stn₃) are reduced to comparatively limited median areas by the encroaching pleural plates (Eps₂, Epm₂, Eps₃). The reduction of the sterna is accompanied, or made possible, by the transference of muscle attachments to the large furcae (Fig. 43, fu₂, fu₃).

The mesothoracic sternum (Fig. 41, Stn₂) is fused with the opening into the pterothorax. This basal rim is thickened in contact with the sternal region of the active prothorax. The mesosternum is divided by a median (mfus) and two lateral inflections (sacs). The latter form the transverse sternacostal suture, setting off the narrow sternellum (Sl₂) from the basisternum (Bs₂). The inflections extend into the furca (Fig. 43, fu₂), the anterior median ridge (mfur) brac-

† Dr. H. B. Hungerford has pointed out that "kneading" the air bubbles may be of importance in respiration. Comstock (Hyatt and Arms, 1890) described *Corixa* as having "its body almost completely enveloped with air, which glistens like silver. This air-film is constantly retained, and probably acts as a tracheal gill, so that the insect is able to remain under water a long time." Kirkaldy (1906) and others have noted the ability of corixids to remain under the surface in pure water for indefinitely protracted periods. Doctor Hungerford reports specimens from depths making frequent trips to the surface impossible. The respiration habits of corixids have been treated by Lamarck (1838), Régimbart (1875), Packard (1877), Brocher (1909), Hagemann (1910), Bueno (1916), Rousseau (1921), Taschenburg (1929), et al. The works of Brocher, Hagemann, Rousseau, and Botjes (1932) are particularly recommended.

ing the posterior transverse plates, or sternal apophyses (which fuse to form the furca). Above the median brace, the furca divides; each fork subdivides into a stout posteromesal prong (pr) and an attenuated anterolateral process (pr'), both flaring at the apex for muscle attachments. Among the muscles attaching on the posterior projection are those reaching the prothoracic and metathoracic furcae and the posterior phragma; the anterior process (pr') connects by short fibers with the mesothoracic pleural apophysis (PlA₂). The precoxal bridge between the episternum and the sternum is not developed separately; the postcoxal bridge from the epimeron probably enters into the anterior margin of the broad plate behind the mesocoxal cavity.

The metathoracic sternum shows behind the contiguous middle coxae in a projection shaped like a spearhead (Sl₃). This is the sternellum (the metaxyphus of taxonomists), set off from the concealed basisternum (Bs₃) by the basal position of the sternal apophyses (sa). The sternellum continues laterally in a flange along the anteroventral margin of the episternum (Eps₃) to the orifice of the scent gland (sgo). The basisternum is concave on either side behind the bulbous mesocoxae. The large metathoracic furca (Fig. 43, Fu₃) rises on two stout pedestals, joining above the hollowed inner sternal surface and forking immediately to form a cradle-like structure which supports the central nerve cords and attachments of important thoracic and abdominal muscles.

THE THORACIC APPENDAGES

The Legs. The example of advanced specialization shown by the corixid legs could scarcely be improved. These instruments of food gathering, anchorage and swimming are arranged along the thorax like the neatly racked tools of any precise workman, exactly fitting their several purposes and in proper position for instant service. The *adaptive* character of the specialization is most interesting. The strikingly different three pairs of legs are basically similar in structural plan, attachment and flexure; the adaptations have been effected largely through *proportional* changes in the typical segmentation (cf. Figs. 45, 47, 48): coxa (Cx), trochanter (Tr), femur (Fm), tibia (Tb), tarsus (Tar) and pretarsus (Ptar).

In each leg, the proximal rim of the coxa, or basicoxite (Bcx), slants from the mesal surface to the lateral, there produced (ap) to articulate with the ventral knob of the pleural ridge (the pleural coxal articulation previously discussed). The proximal attachment is completed by the flexible membrane, or coxal corium, joined to

the pleural and sternal walls within the coxal cavity. The reduced trochantin (Fig. 47, Tn) in the membrane attaches ventrally on the basicoxite. The converging coxae are nearly horizontal and thus overlapped by the anterior margins of the coxal cavities. The monocondylic pleurocoxal joint permits rotation and lateral movements, limited by the circumcoxal boundaries. The remaining joints of the limb segments are dicondylic, the greatest flexion occurring on the coxotrochanteral and femorotibial axes. In the middle and hind legs, extended backward against the venter, these axes are nearly vertical, as are the tibiotarsal and tarsopretarsal axes. In the forelegs in a similar position, the distal axes are altered to nearly horizontal by a torsion of the oblique trochanterofemoral axis from horizontal to nearly vertical, tending to crook the palae (foretarsi) forward beneath the rostrum.

The stout prothoracic legs (Fig. 44-46) are perfectly adapted for gathering the peculiar dietary requirements of the water boatman. The tarsi, or palae (Tar), are given emphasis in this function and are proportionally enlarged. The tarsus, femur and coxa are the longer segments of the foreleg; the short tibia and the trochanter are nearly equal. The cylindrical coxa bears a conspicuous round pit, possibly sensory, on the upper lateral surface (Fig. 44, p). The pretarsus is represented only by the curved apical claw, provided with tendon and flexor muscle and serving as an active raptorial element in the setal basket on the tarsus.

In position beneath the rostrum, the spoonlike female palae are triangular in section with the thickened anterior surface tapering to the posterior margin. The curved upper surface, passed under the ridged face of the rostrum in feeding, is finely spined and bordered with setae; a few slender spines are set along the under surface. The posterior marginal setae and a row on the anterior surface are especially long, completing the basket and sifter of an efficient tarsal instrument for digging and sorting the food organisms from ooze.

The specific variance in shape of the male palae (Fig. 46, Tar) is of taxonomic importance. The row of pegs (pg) on the upper anterior area has been considered of use in chirping, the sound supposedly produced by the pegs grating on the furrowed rostrum (Ball, 1845; Landois, 1874; Schmidt, 1891; Handlirsch, 1900; Howard, 1905; Maxwell-Lefroy, 1923; Lenz, 1928; Taschenberg, 1929; et al.). Handlirsch (1900) also suggested that the males might chirp with the strigil (on the abdomen, q. v.), and this was in part supported by Carpenter (1924). Kirkaldy (1901) assigned the stridulation

of corixids to the action of the tarsal "comb" against the "stridulatory area" on the inner surface of the opposite femur, though admitting it must need "very considerable gymnastic efforts." (cf. Hutchinson, 1929.) It has been established, however, that chirping results from the friction of the stridular patch on the femur (Fig. 46, str) across the thin lateral margins of the head. This was suggested by Carpenter (1894), by Hagemann (1910), and confirmed by Mitis (1935), who described the scraping of the "chirping field" over the sharp cephalic margin between the antenna and the rostrum. Air chambers of the head and prothorax were said to add resonance.

The mesothoracic legs are greatly elongated (Fig. 47), acting together from the contiguous bulbous coxae as a pair of tongs, striking deep anchorage for the buoyant corixid in the ooze where it feeds. The long segments taper evenly, with progressive reduction, from the oblique union with the short trochanter to the pretarsus, here represented by a pair of slender claws. These claws are operated by a single flexor tendon, as in the foreleg. The distal limb segments are lined with spines and setae, particularly dense on the tibia and tarsus. The leg is never completely straightened on the femorotibial joint; a slight twist on the oblique trochanterofemoral axis aids the coxa in turning the apical segments back, trailing loosely under the venter in swimming, and the reverse movement brings the claws in direct opposition in the anchoring position.

The metathoracic legs are large, efficient swimming limbs (Fig. 48), in their action combining locomotive power with the niceties of "feathering" necessary in the use of oars under water. The helmet-shaped coxa and the activating muscles are far superior to the comparable mechanism in the anterior and middle legs. The pleural coxal articulation is extremely lateral, and the most important metathoracic muscles enter the limb through the large coxal cavity. The driving stroke is made with the "oar" extended from the coxotrochanteral axis near the center of the body. This position plainly contributes to rapid maneuverability. The elongated, flattened tarsus is the blade of the oar, with the pretarsus forming the apex. The long segments are lined with spines and setae, as in the middle leg, arranged on the tibia and, particularly, on the tarsus in posteriorly directed fringes, adding to the effectiveness of the paddle. Flexure on the oblique trochanterofemoral axis rotates the length of the limb, presenting the face of the blade on the stroke and its edge on the return.

The Wings. Water insects in flight seem to represent an organ-

ismic ideal of the flying submarine, the Corixidae no less than others. The wings of such insects must be capable of assuming with equal speed and efficiency the *aquatic* or the *aërial* position in the swift change of environment. In the water, the gauzy hind wings of the corixid are folded neatly under the shielding forewings, which are tightly fitted in the flexed position, contributing largely to the requisite trimness of the smooth back. In the air, the wings are extended to whirring activity and that remarkable proficiency in flight shown by many insects molded as distinctly, almost perfectly, for life under water.

As usual in Hemiptera, the corixid forewing ("hemelytron" or "tegmen") is heavier basally, with a distal membrane (Fig. 49, Mb). The basal portion is divided diagonally (vf) into the inner, or posterior, "clavus" (Cl) and the outer, or anterior, "corium" (Cm) (Comstock, 1918)—morphologically the vannus (Vs) and the remigium (Rm) (Snodgrass, 1935), as shown on the hind wing (Fig. 50). Sealing over the folded posterior wings, the vannal regions of the flexed anterior wings join tightly along the middle length of the body (Fig. 3) and the slanting inner proximal margins, varyingly overlapped by the pronotum, fit into the deep V-furrow on the mesothorax. (Fig. 40, WG.) The outer areas of the flexed forewings also turn down—the eaves of the roof over the abdomen. The right "membrane" (Fig. 49, Mb) is almost as heavily sclerotized as the basal areas, and regularly covers the left, which is often marginally lighter (particularly in *Ramphocorixa acuminata*). The distal array of veins commonly found in terrestrial Hemiptera is missing; most of the wing venation is concentrated in simple basal girders. Corixids are usually tigroid in appearance, with stripes on the pronotal shield and sinuous transverse mottlings on the forewings. These markings are less distinct in *Ramphocorixa*.

In the flexed hindwing, the vannus bends under the remigium along the vannal fold (Fig. 50, vf), with accessory pleating in both wing regions. Either wing may lie over the other, though the right usually overlaps the left. The fanlike, diaphanous membrane is strengthened in the anterior remigium and middle vannus by veins with enough pigmentation and relief to show plainly. The veins in the posterior remigium are less easily traced.

When extended, both wings show an arrangement of tiny articular sclerites, more or less fused, at the humeral angle (Figs. 49, 50, aAx, 3Ax). These essential parts of the wing base mechanism are important in establishing the wing vein homologies (Snodgrass, 1935;

Levereault, 1936). The relations are shown best on the ventral side of the wing bases, with the plane of each wing fully extended upward (Fig. 39). In both wings (W_2 , W_3), the costal margin rotates outward as the plane of the wing turns forward and up in the movement of extension. The fulcrum for all wing movement is the pleural wing process (plw_2 , plw_3), articulating with the fused anterior axillary (aAx_2 , aAx_3). This axillary is evidently a composite of the humeral (costal) plate, the first (subcostal) and the second (radial) axillaries, the latter resting typically on the pleural process.

The third (vannal) axillary in the forewing ($3Ax_2$) is represented by a flexible chain of four pieces next the basal vannus and the axillary cord (Axc_2). The tiny sclerotized parts assume relations in the extended wing which help lock the base in the flight position. Flexion begins with the contraction of the strong muscle reaching from the pleural ridge to the proximal part of the chain, tripping the mechanism. In the hindwing, the third axillary is represented by two hinged bars ($3Ax_3$), the proximal receiving the flexor muscle from the pleural ridge. This muscle is proportionally weaker than its homolog in the forewing which is the greater force in initiating the flexion of both wings. The action is controlled by relaxation of the powerful thoracic muscles responsible for wing extension and flight movements through flexure of the adjacent tergal areas. Wing flexion is completed by retraction of the pronotum over the wing bases.

The basal sclerotic fields in the hind wing (Fig. 50, Mp, Mp'), articulating with the anterior and third axillaries, represent the divided median plate (medial axillary). These fields are less easily defined in the general sclerotization of the forewing, but are probably the basal scroll-like development, attached to the anterior axillary, and the adjacent triangular area (Fig. 49, Mp, Mp'). The posterior wing shows best the established relations of axillary sclerites and wing veins, used here in determining the homologies of corixid wing venation and generally indicated by the parenthetical terminology given each axillary above (cf. Levereault, 1936).

In the hind wing (Fig. 50), costa (C), subcosta (Sc), and radius (R) are fused in a marginal girder articulating with the anterior axillary (aAx_3). The extension of the radius into R_1 and the radial sector (Rs) is similar to the branching in Notonectidae (Hutchinson, 1929). The radial sector is apically forked (R_{2+3} , R_{4+5}). Media (M) and cubitus (Cu) are based on the median plates (Mp, Mp'). The anterior branch of media (M_{1+2}) fuses with the radial sector

and the free posterior branch (M_{3+4}) runs through a large pleat of the wing. The medial (m) and mediocubital (m-cu) cross-veins are broken at the edges of the pleat. Cubitus branches at the base (Cu_1 , C_2); the anterior vein is forked (Cu_{1a} , Cu_{1b}), meeting the tip of Cu_2 . The strong vannal vein (V) articulates with the third axillary (3Ax), bracing the postaxial plane of the wing.

In the forewing (Fig. 49), costa, subcosta and radius (C+Sc+R) are fused in the thickened costal margin, extending from the anterior axillary (aAx₂) and intersected by the "nodal furrow" (nf). Media (M) and cubitus (Cu) arise from the median plate—the former from the proximal scroll-like piece (Mp), the latter from the distal triangular area (Mp')—and meet at the "nodal furrow." Continuing from this point, the fused veins are apparently joined by the down-curving distal part of radius (R+M+Cu). The strong vannal vein (V) converges on the vannal fold (vf) from the basal vannus, which articulates with the third axillary (3Ax) and is crossed by the marginal line reached by the overlapping pronotum (ml). In both wings the jugal region is suppressed, appearing at most as an inner postaxial pleat of the hind wing.

THE ABDOMINAL SKELETON

Compared with the head or the thorax, the abdomen seems relatively unspecialized. Form and function in this important body region fit easily into the aquatic environment without extensive alteration from the generalized plan. The corixid abdomen is the longest and widest region of the body, though its bulk is reduced by flattening and tapering, completing the typical reversed boat shape (Figs. 4, 9, 51). The proportions of the abdomen are incidental to its importance in housing the principal organs of nutrition, excretion and reproduction, with the associated major circulatory, respiratory and neural channels. The segments of the abdomen are most conveniently discussed as *visceral*, or pregenital, and *genital*—the former containing the mass of the organs suggested, and the latter altered to form the accessory instruments of reproduction (Snodgrass, 1935; Levereault, 1936; Larsen, 1938). Generally speaking, segments I-VII compose the visceral region, segments VIII and IX the genital; though the curious sexual dimorphism also involves the male segments IV-VII in the latter. The postgenital region is simplified and unsclerotized in Corixidae.

THE VISCERAL REGION

The Primary Segments (I-III). The metathoracic postnotum (Fig. 40, Pn_3), set off by the axillary cord (Axc₃), represents the

acrotergite of the first abdominal antecosta (Snodgrass, 1935). The sclerites of the first segment posterior to this inflection are reduced in Corixidae to the median sternal prong (Fig. 56, I Stn) uniting with the metathoracic furcasternum, and the bilobed tergite (Fig. 51, I T). The latter thrusts forward in a shelf over the membranous connection with the antecosta; the flexible unsclerotized fore-portion of the first tergum becomes the functional dorsal intersegmental membrane. In each lateral corner, bounded by the thoracic lobe, is the large first abdominal spiracle (I Sp). The membrane continues posterior to the spiracle, deeply notching the second tergal plate (II T) which is firmly joined to the first. The second and third terga (III T) are flexibly united in secondary segmentation as described below.

Union with the thorax is completed by the lateral articulation of the second abdominal segment with the thoracic lobes beside the first segment. The second sternal antecosta is bilobed (Fig. 43, II Ac'), and continues laterally into strong anterior processes (II pr). The large muscles attached (on the median lobes from the metathoracic furca and the anterior third sternal area, on the lateral processes from the first tergite) serve in the action of the abdomen on the mesal and lateral articulations with the thorax. The ventral wall of the second segment (Fig. 56, Ltg, II Stn) forms the posterior margins of the metacoxal cavities (cf. Brindley, 1938), and is concave laterally above the coxae. The spiracles are in these lateral hollows near the bases of the antecostal processes (II Sp). The ventral third segment is divided by a semicircular inflection into anterior and posterior areas (Figs. 42, 43, 56, III Stn₁, III Stn₂), the former also concave above the converging metathoracic coxae. The spiracles are in the lateral posterior areas (III Sp), nearer the margins and smaller than the preceding pair. All of the ventral abdominal spiracles have an inner valvular cone, seemingly an exhaust mechanism like that in the dorsal first pair (p. 318), though reduced and withdrawn.

With the special features indicated, the primary abdominal segments, when complete (second and third), show the typical compressed ring form (Fig. 54) found in the remainder of the visceral region, though with greater median bulk.

Sexual dimorphism (IV-VII). The general segmentation in the female corixid abdomen (Fig. 51) forms a regular series of sclerotic annuli (Fig. 54). The broad tergal and sternal plates (T, Pl-Stn) continue laterally into blade-thin areas (Ltg), tilted up in wide dorsolateral rims with strong setae on the sharp margins. The dor-

sal plates are flexibly subdivided laterally, setting off the laterotergites (Ltg); but the true tergopleural lines are ventral, as shown by the position of the spiracles (Sp), always dorsad to the pleura. The median ventral plates, fused with the lateral, are thus pleurosternal (Pl-Stn), or laterosternal, morphologically.

The laterotergites occupy progressively more of the marginal areas, each hooking backward over the curved anterior corner of the succeeding segment. The small spiracles (Fig. 56, IV-VII Sp) are close upon the faint tergopleural line. The hairy investiture, exposed on the ventral plates and the apical dorsum, is much denser than that on the covered tergal areas. Vestiges of the dorsal nymphal glands are sometimes evident on, or near, the mesal posterior margins of the fourth and fifth tergal plates in both sexes (Figs. 51, 55, gl).

The sagittal section (Fig. 42) shows typical secondary segmentation, with the functional intersegmental membranes (Isgm) removed forward from the antecostae (Ac), or primary intersegmental inflections, and overlapped by the posterior tergal and sternal margins. The median bulk of the abdomen decreases evenly toward the apex. The median caudal margin of the ventral seventh segment thrusts over the eighth, forming the so-called subgenital plate (Fig. 52, sgpl).

In the male corixid abdomen (Figs. 55, 56), segments IV-VII are warped in the asymmetry (Hagemann, 1910) peculiar to the several genera—in taxonomy, “dextral” in *Arctocorixa*, *Corisella* and *Ramphocorixa*, “sinistral” in *Trichocorixa*—though individual cases of reversal have been noted (Hungerford, 1928). The asymmetry results from the subdividing of the posterior tergal and sternal plates by secondary lines of flexure, and the shortening of one side of the segments involved, accompanied by irregular lobular developments. The complicated, flexible pattern assists the coupling of the sexes, with the male on top and the tip of the abdomen curving down and around one side, according to the nature of the asymmetry. Larsen (1938) has described in an extensive work the structure and function of the pregenital and genital regions of *Corixa dentipes* and *Sigara sahlbergi*, the former with sinistral, the latter with dextral asymmetry. The irregular skeletal developments are specifically variable; *Ramphocorixa acuminata* will be described and figured as a typical example.

The spiracles in the male have the same position as in the female abdomen; the laterotergites are similarly developed, though the

tergopleural lines are not evident. Changes in the median tergal and sternal areas are largely responsible for the male asymmetry. The fourth tergum (Fig. 55, IV T) is posteriorly bilobed, the right lobe larger and both lined with long setae. These lobes are weakly duplicated on the sternum (Fig. 56, IV Stn), and the diagonal cast thus given the undulating posterior dorsal and ventral margins of the fourth segment is continued by those following.

The fifth and sixth terga (Fig. 55, V, VI T) are lobate on the right, and detached posteriorly from the laterotergites on that side. The sterna (Fig. 56, V, VI Stn) are divided on the right by the slanting lines of flexure—angling inward on V, outward on VI—and deep posterior marginal notches. This flexible arrangement is reflected on the terga by a less distinct line of flexure on the fifth lobe and a shallow excavation on the sixth. The latter bears the tiny strigil (Fig. 55, stgl) on a process of the posterior margin. This curious structure resembles a comb lying flat with the teeth inward; though suspected of a part in stridulation in some Corixidae, its true service is in gripping against the female venter in copulation (Larsen, 1938). The stout setae on the posterior margin of the fifth tergal lobe are called the prestigil by Larsen, who described their action in fastening on the margin of the female forewing. The IV-V and V-VI intersegmental membranes are extended, particularly on the right, permitting the segments to twist to the left side and under the female.

The seventh tergum (Fig. 55, VII T) is deeply notched on the left, with a mesal terminal lobe; the sternum (Fig. 56, VII Stn) has the same general condition, but with the notch and line of flexure on the right, continued from the preceding sterna, as described (V, VI Stn). The extension of the VI-VII intersegmental membrane is particularly evident on the left, permitting the abdominal apex to turn back under the venter of the female.

THE GENITAL REGION

Male. The eighth segment of the male corixid is terminal and divided into asymmetrical halves, each bearing long, apical setae and the tiny ventral spiracle. An inner lobe of the left tergite (Fig. 55, VIII T) encroaches on the right which is correlatively reduced. The condition is reversed by the sternal plates, the right (Fig. 56, VIII Stn) being the larger. This effects a torsion in the chamber formed by the halves of the segment, containing the male copulatory organ. The latter consists of the intromittent phallus based in the capsulate ninth segment (Figs. 57, 58). The segment lies on its right side,

swinging out to the right for union with the female. The extreme curvature of the phallus turns it forward into the vagina when the apical male abdomen is lowered under the female venter.

The ninth tergum (Figs. 57, 58, IX T) is represented by the narrow posterior band on the right. The disproportional sternum (IX Stn) is like a lopsided basket attached to the tergal "handle." The ventral wall is the larger; the left (true ventral) side extends posteriorly in a stout forked process (pr), grooved on the inner side to guide the phallus. Two flattened appendages, irregularly falciform (vhrp, dhrp), articulate on the posterior rim of the ninth segment. These are the lateral harpagones (parameres of Singh-Pruthi, 1925, et al.; genitalhaken of Larsen, 1938; also gonapophyses, claspers or styles of taxonomists), twisted with the segment to dorsal and ventral positions. The dorsal, or left, harpago (dhrp) is heavier and with a larger apodeme for muscle attachment; the grooved inner surface, with an encircling extension near the base (x), assists the posterior sternal process in guiding the phallic shaft.

The corixid phallus is a complex and curious organ. The curved, flexible copulatory shaft arises from the stout phallobase (Fig. 57, Phb) which articulates on the bases of the harpagones. As the phallobase turns on its dorsoventral axis, the long phallus thrusts out between the clasping dorsal harpago and the sternal process. The intromittent organ is remarkably curved, suggesting an interrogation mark in ventral view. Its parts are the outer phallotheca (The; the phallosoma of Singh-Pruthi and Larsen); its inner wall, or endotheca (Singh-Pruthi's conjunctiva of the endosoma, Larsen's schwellkörper); and the enclosed needle-like aedeagus (Aed; Singh-Pruthi's vesica of the endosoma, Larsen's flagellum). The basic relations identifying these parts are diagrammed by Snodgrass (1935). The partially sclerotized phallotheca returns elastically to the looped position on relaxation of extrusive pressure. The tip flares into lateral processes, and is not quite reached by the membranous endotheca which opens on the side. The slender aedeagus enclosed by the phallothecal walls extends beyond the opening to the spreading apex of the phallotheca. The hollow needle of the aedeagus joins directly on the ejaculatory duct in the phallobase, and must serve to direct the passage of sperm within the vagina.

The proctiger (Fig. 57, Ptgr) extends as a membranous tube from the tergal region of the ninth segment, directed to the right of the phallic and paraphallic structures. The anus (an) is apical in the membrane. The proctiger comprises the simplified postgenital region in Hemiptera (Snodgrass, 1935).

Female. The eighth segment of the female corixid abdomen resembles that of the male, but the division into lateral halves is symmetrical. The tergum (Fig. 51, VIII T) consists of the divided dorsal lobes, meeting on the mesal line, and the laterotergites which bear the ventral spiracles. The median part of the sternum (Fig. 53) is separate and enclosed by the lateral lobes of the eighth segment (Fig. 52, VIII) and the subgenital plate (Sgpl) (Larsen, 1938). The apex and margins are sclerotized, the median base membranous. The basal apodemes (Fig. 53, pr) receive extrusive muscles from the lateral lobes. When these lobes are spread in oviposition (p. 297), the valvulae of the ovipositor (Larsen's gonapophyses) are exposed. The first pair (1 VI) are apical on the eighth sternal plate, each tipped with a fingerlike process and a flexible stylus (sty; Crampton's gynostyle, 1929a). The second valvulae (2 VI) are flattened just above the first, arising from the ventral ninth segment. The two pairs of spiny-tipped valves enclose the large vaginal orifice (vulva). The ninth tergum (Fig. 51, IX T) is best developed apically and laterally, forming a tiny sclerotic crescent; the proctiger (Ptgr) is also sclerotized dorsally. Both pieces are exposed by the gaping tergal lobes of the eighth segment.

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LIST OF ABBREVIATIONS

The abbreviations are alphabetized for *head, thorax, legs, wings* and *abdomen*. Those which refer to orientation, inflections and processes will be found clarified in the discussion of the structure figured.

HEAD

Ant, antenna	lbo, labial orifice
As, antennal socket	Lbs, labial shaft
at, attachment of labial shaft	Lm, labrum
Br, brain	m, mesal
br, bar	Mcl, muscle
ca, cranial articulation	mda, mandibular articulation
cgo, cephalic gland orifice	mdl, mandibular lever
clbcy, contractor of labial cylinder	Mdpl, mandibular plate
Clp, clypeus	MdS, mandibular stylet
cs, coronal suture	Mr, masticator
cva, cervical articulation	Mth, mouth
d, dorsal	Mxpl, maxillary plate
det, salivary duct	MxS, maxillary stylet
dlbc, dilator of buccal region	o, ocellus (or vestige)
dlbo, dilator of labial orifice	Oc, occiput
dlcb, dilator of cibarial region	pes, paraclypeal suture
dlphy, dilator of pharyngeal region	Pdc, pedicel
dlpphy, dilator of postpharyngeal region	pfs, postfrontal suture
dlsyr, dilator of syringe	Phy, pharynx
E, compound eye	pmd, protractor of mandible
Es, esophagus	Pmp, sucking pump
Fl, flagellum	pmx, protractor of maxilla
For, occipital foramen	Poc, postocciput
Fr, frons	Pphy, postpharynx
FrGng, frontal ganglion	pr, process
g, groove	PrClp, paraclypeus
Ge, gena	r, ridge
h, hinge	rmd, retractor of mandible
Hos, hypocular strut	rmx, retractor of maxilla
hos, hypocular suture	Ro, rostrum
Hphy, hypopharynx	Sep, scape
l, lateral	sm, salivary meatus
Lb, labium	Soc, subocciput
Lbcy, labial cylinder	Syr, salivary syringe
	Vx, vertex

AC, air chamber
 Ac, antecosta
 acs, antecostal suture
 Axc, axillary cord
 Bs, basisternum
 cva, cervical articulation
 Cvx, cervix
 cxap, coxal articulation process
 Epm, epimeron
 Eps, episternum
 f, furrow
 fu, furca
 h, hook
 lsgm, intersegmental membrane
 lbe, lobe
 mfur, median furcal ridge
 mfs, median furcal suture
 mr, median ridge
 ms, median suture
 no, notaulix
 Pcx, postcoxale
 Ph, phragma
 PLA, pleural apophysis
 pla, pleural apophysial pit

ap, articular process
 bcs, basicoxal suture
 Bcx, basicoxite
 Cx, coxa
 Fm, femur
 p, pit

aAx, anterior axillary
 3Ax, third axillary
 Axc, axillary cord
 C, costa
 Cl, clavus
 Cm, corium
 Cu, cubitus
 M, media
 m, median cross-vein
 Mb, membrane
 m-cu, mediocubital cross-vein

THORAX

plr, pleural ridge
 pls, pleural suture
 plst, pleurosternal bridge
 plw, pleural wing process
 Pn, postnotum
 pr, process
 Prcx, precoxale
 Prsc, prescutum
 rvs, reversed notal suture
 sa, sternal apophysial pit
 sacs, sternacostal suture
 Scl, scutellum
 Sct, scutum
 sgo, scent gland orifice
 Sl, sternellum
 sl, scroli
 Sp, spiracle
 Stn, sternum
 T, tergum
 ts, transverse suture
 Tymp, tympanal organ
 W, wing
 WG, wing groove
 1, 2, 3, pro-, meso-, metathoracic

LEGS

pg, pegs
 Ptar, pretarsus
 str, stridular area
 Tar, tarsus
 Tb, tibia
 Tn, trochantin
 Tr, trochanter

WINGS

ml, marginal line
 Mp, median plate
 nf, nodal furrow
 R, radius
 Rm, remigium
 Rs, radial sector
 Sc, subcosta
 V, vannal vein
 vf, vannal fold
 Vs, vannus
 2, 3, meso-, metathoracic



ABDOMEN

Ac, antecosta	Ptgr, proctiger
acs, antecostal suture	Sgpl, subgenital plate
Aed, aedeagus	Sp, spiracle
an, anus	stgl, strigil
dhrp, dorsal (left) harpago	Stn, sternum
gl. gland (or vestige)	sty, stylus
Isgm, intersegmental membrane	T, tergum
Ltg, laterotergite	Thc, phallotheca
ms, median suture	vhrp, ventral (right) harpago
Phb, phallobase	VI, valvifer
Pl-Stn, pleurosternum	x. extension
pr, process	I-IX, 1st to 9th abdominal

PLATES

The figures, unless otherwise indicated, represent structural studies of *Ramphocorixa acuminata* (Uhler). The gross regional views were drawn using an ocular micrometer at 42.5x. Detailed studies were made with higher magnification, using a camera lucida for the sagittal sections and the wings. The figures are intended as studies in proportion and relationships; the surface ornamentation has been sparsely indicated.

PLATE XVI

- FIG. 1. Lateral view of egg
FIG. 2 Eggs on *Cambarus simulans* Faxon
FIG. 3 Dorsal view of male.
FIG. 4 Dorsal view of female.

PLATE XVI

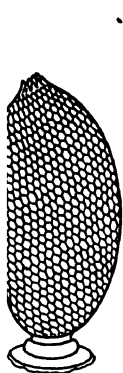


FIG 1

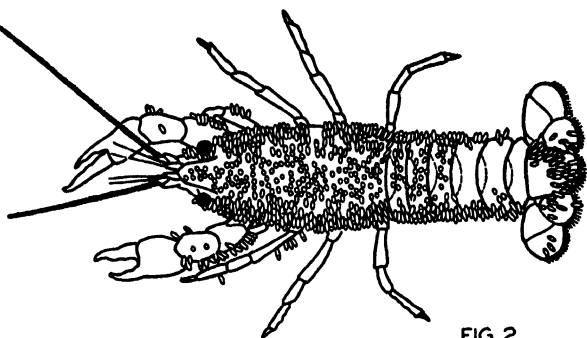


FIG 2

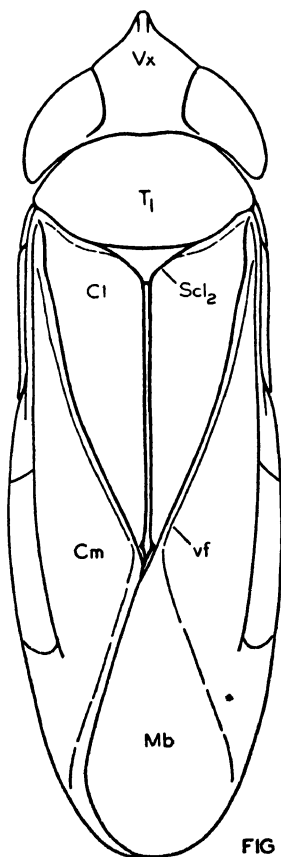


FIG 3

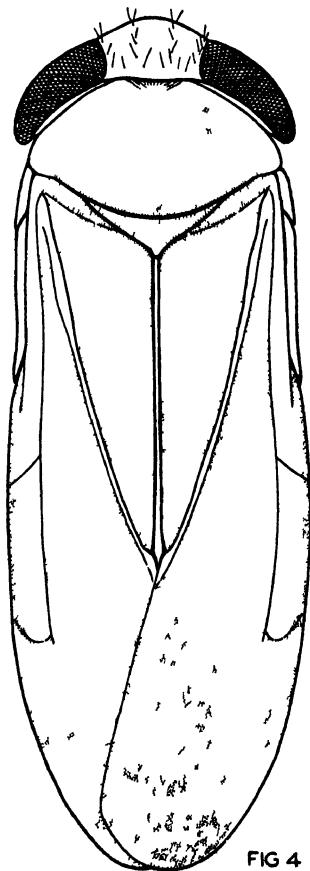


FIG 4

PLATE XVII

- FIG. 5. Dorsal view of first instar.
FIG. 6. Dorsal view of second instar.
FIG. 7. Dorsal view of third instar.
FIG. 8. Dorsal view of fourth instar.
FIG. 9. Dorsal view of fifth instar showing color pattern.
FIG. 10. Vertex of *Diaprepocoris barycephala* Kirk.
FIG. 11. Lateral view of egg drawn in proportion to Figs. 3-9.

PLATE XVII

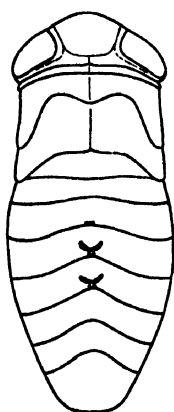


FIG. 7

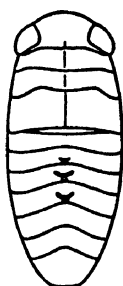


FIG. 6

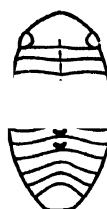


FIG. 5

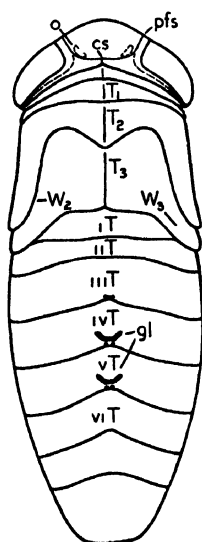


FIG. 8



FIG. 10

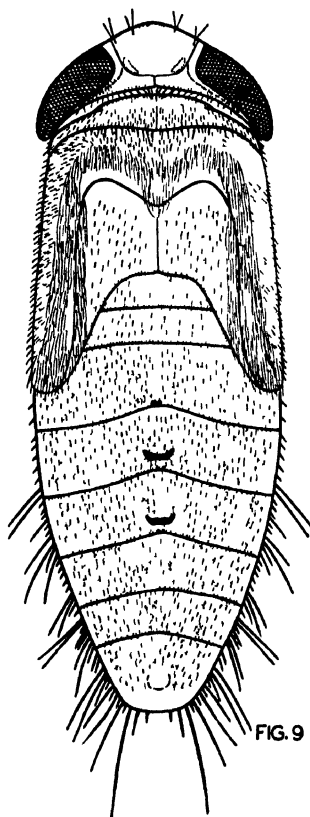


FIG. 9

PLATE XVIII

- FIG. 12. Apical view of hatching egg. d = dorsal.
FIG. 13. Lateral view of hatching egg.
FIG. 14. Apical view of hatching egg.
FIG. 15. Remnants of digested algae found in dissection.
FIG. 16. Remnants of digested rotifers found in dissection.

PLATE XVIII



FIG 12



FIG 13



FIG 14

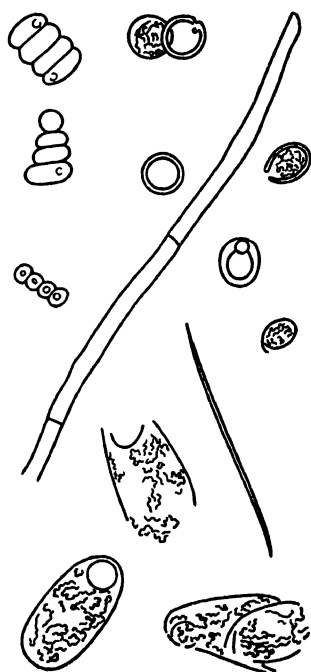


FIG 15



FIG 16

PLATE XIX

- FIG. 17. Lateral view of male head.
FIG. 18. Anterior view of male head.
FIG. 19. Posterior view of female head.
FIG. 20. Lateral view of female head.
FIG. 21. Anterior view of female head.

PLATE XIX

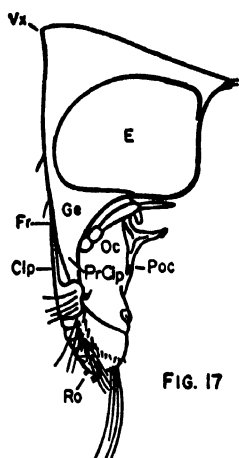


FIG. 17

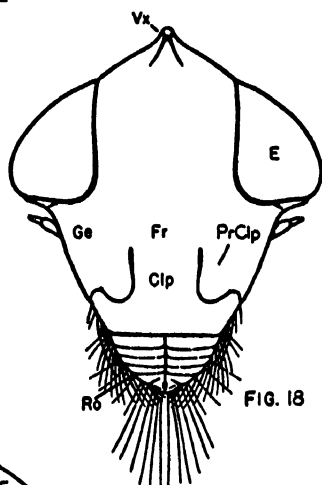


FIG. 18

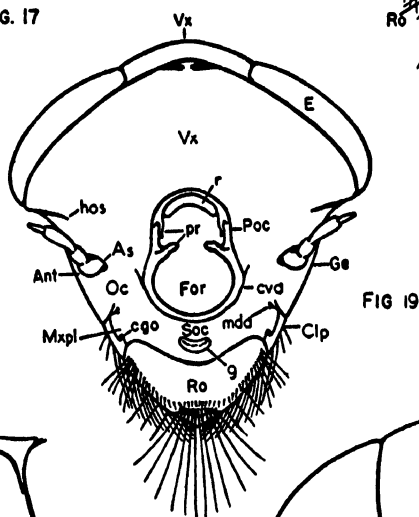


FIG. 19

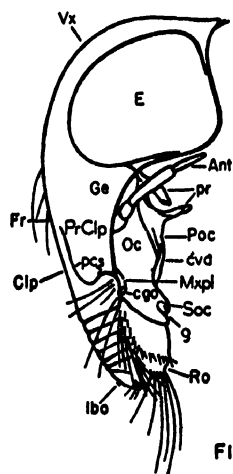


FIG. 20

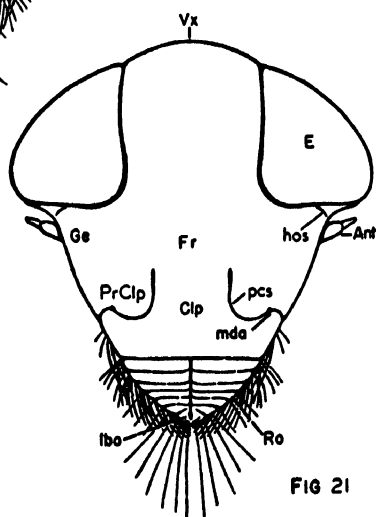


FIG. 21

PLATE XX

FIG. 22. Median sagittal section of head (*Arctocoriza* sp.).

FIG. 23. Median sagittal section of head (*Notonecta* sp.).

FIG. 24. Lateral view of cranial apex after removal of rostrum

FIG. 25. Anterior view of structures within cranial apex after removal of rostrum. Margin of clypeus indicated by broken line.

FIG. 26. Posterior view of antenna and hypocular strut.

PLATE XX

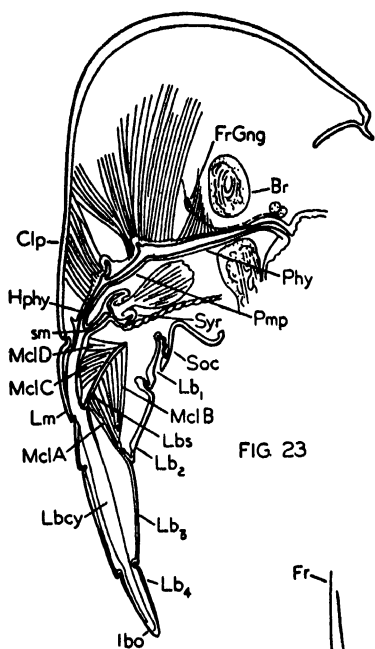


FIG. 23

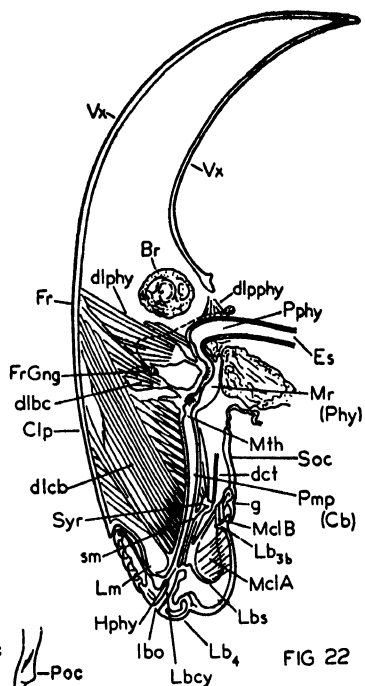


FIG. 22

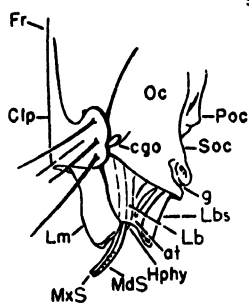


FIG. 24

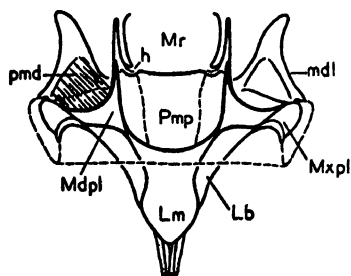


FIG. 25

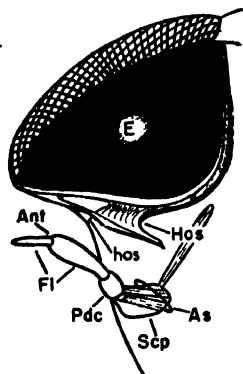


FIG. 26

PLATE XXI

- FIG. 27. Anterior view of right mandibular stylet.
FIG. 28. Posterior view of right mandibular stylet.
FIG. 29. Posterior view of ingestive structures within cranial apex.
FIG. 30. Anteromesal view of right maxillary stylet.
FIG. 31. Anteromesal view of left maxillary stylet.
FIG. 32. Anteromesal view of apex of left maxillary stylet.
FIG. 33. Dorsal view into rostrum.
FIG. 34. Anterior view of rostrum.

PLATE XXI

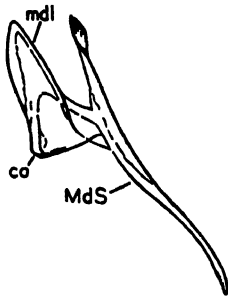


FIG 27



FIG 28

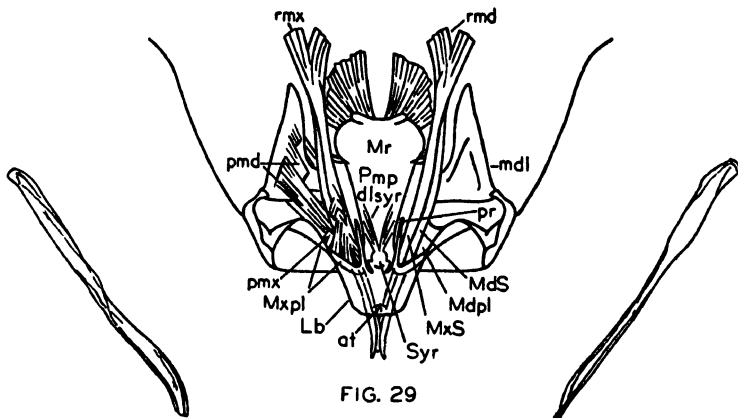


FIG. 29

FIG 30

FIG. 31

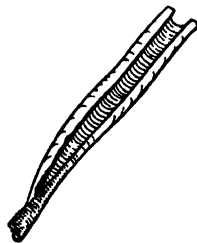


FIG. 32

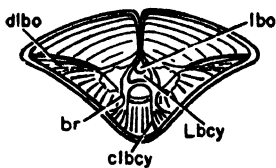


FIG 33

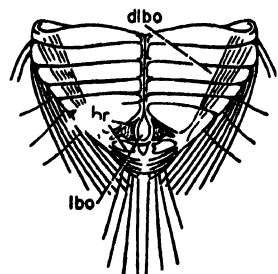


FIG. 34

PLATE XXII

- FIG. 35. Anterior view of prothorax
FIG. 36. Posterior view of prothorax
FIG. 37. Ventral view of prothorax
FIG. 38. Lateral view of prothorax
FIG. 39. Lateral view of pterothorax.

PLATE XXII

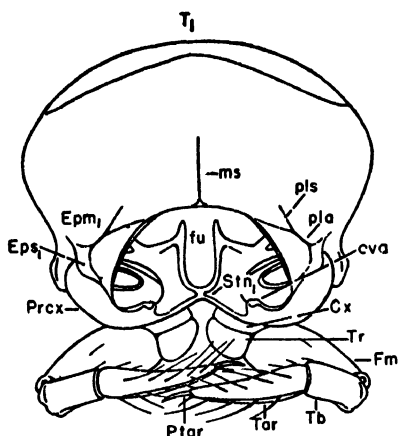


FIG 35

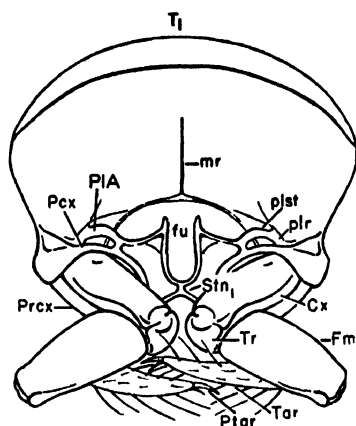


FIG 36

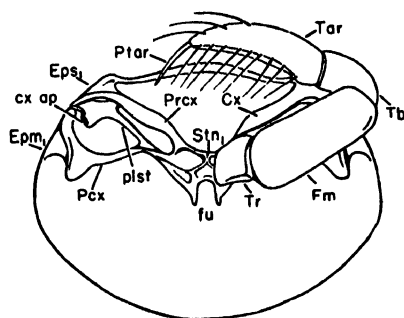


FIG 37

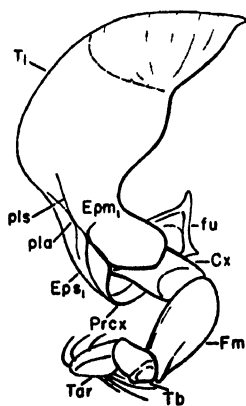


FIG 38

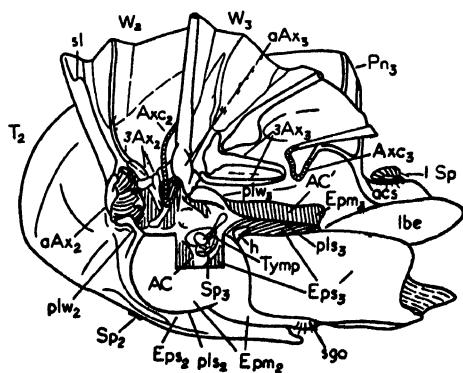


FIG 39

PLATE XXIII

FIG. 40. Dorsal view of pterothorax.

FIG. 41. Ventral view of pterothorax

PLATE XXIII

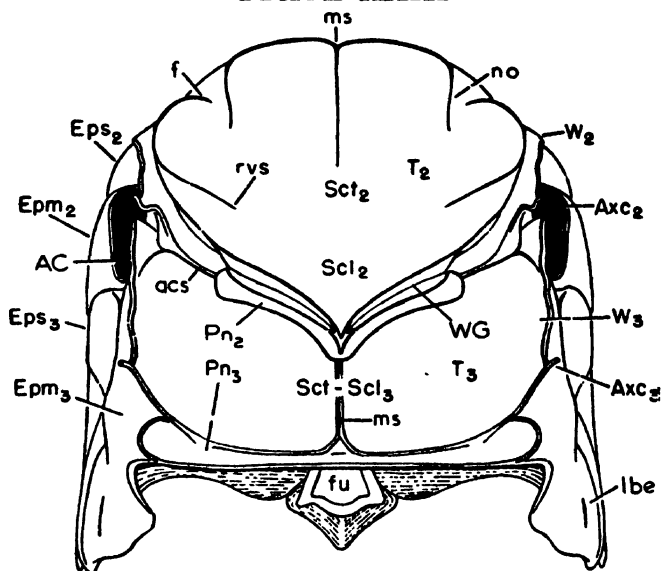


FIG. 40

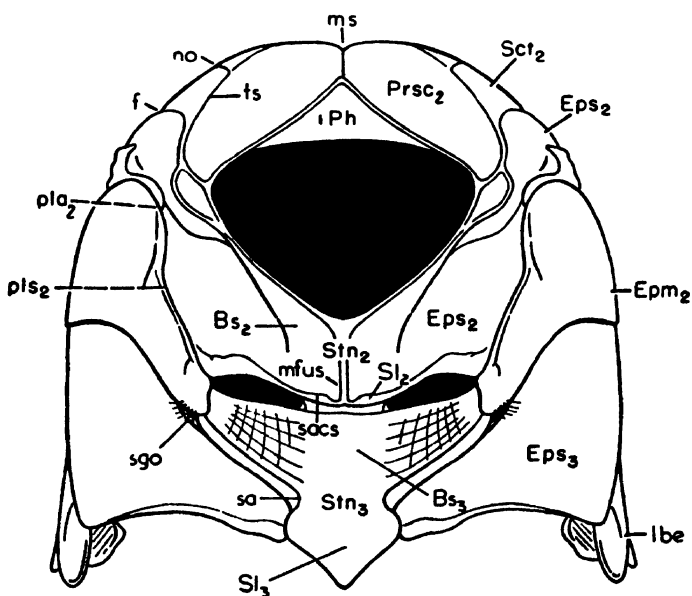


FIG. 41

PLATE XXIV

FIG. 42. Median sagittal section (*Arctoconira* sp.).

FIG. 43. Median sagittal view within pterothorax and basal abdomen.

PLATE XXIV

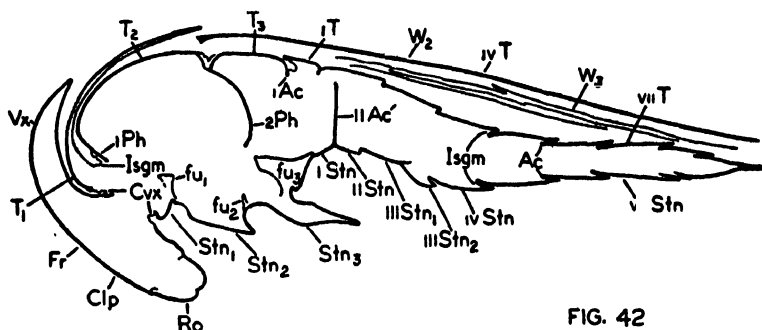


FIG. 42

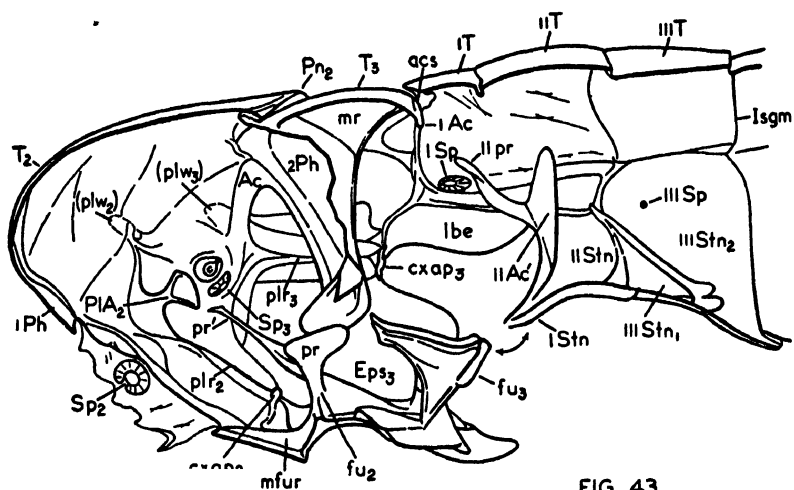


FIG. 43

PLATE XXV

FIG. 44. Posteroventral view of left prothoracic leg of female.

FIG. 45. Anterodorsal view of left prothoracic leg of female.

FIG. 46. Anterodorsal view of left prothoracic leg of male. Figs. 44-46 are much enlarged in comparison to other figures.

FIG. 47. Anteroventral view of left mesothoracic leg.

FIG. 48. Anteroventral view of left metathoracic leg.

PLATE XXV

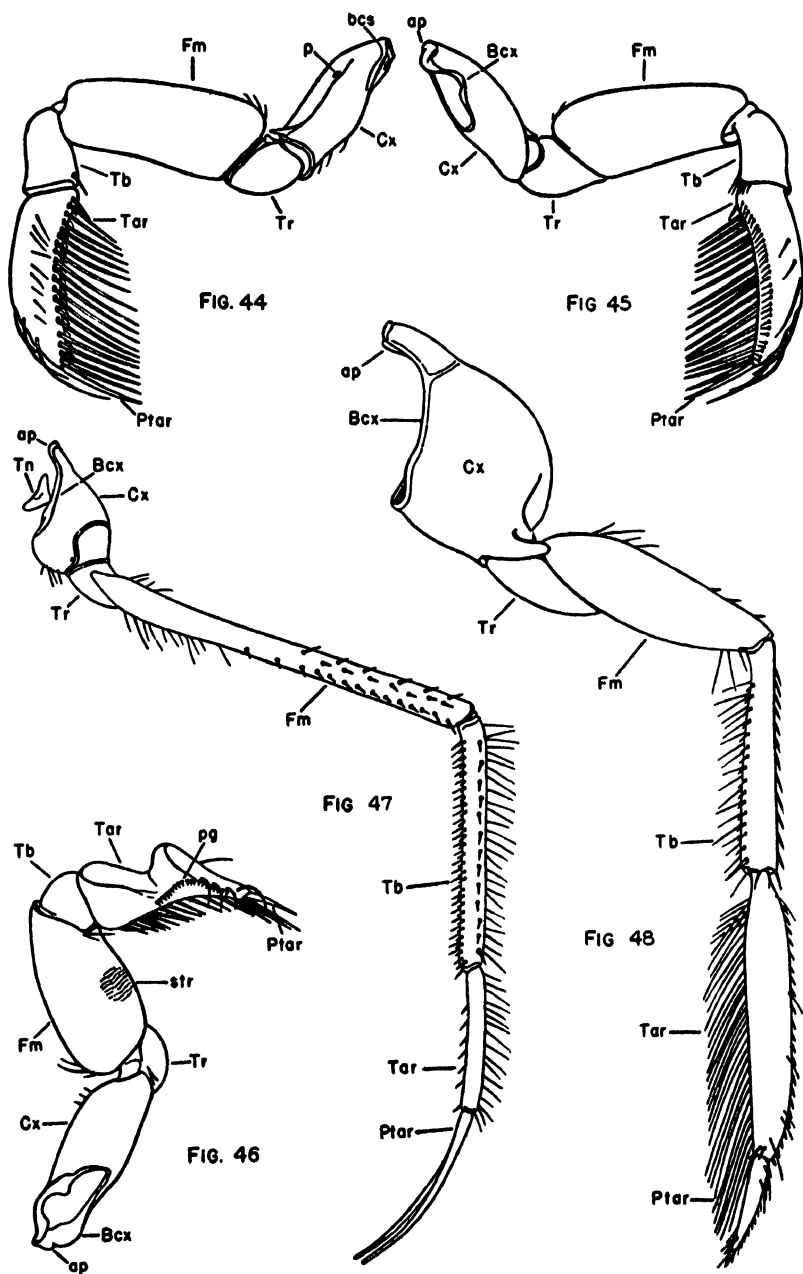


PLATE XXVI

FIG. 49. Dorsal view of right mesothoracic wing.

FIG. 50. Dorsal view of right metathoracic wing expanded.

PLATE XXVI

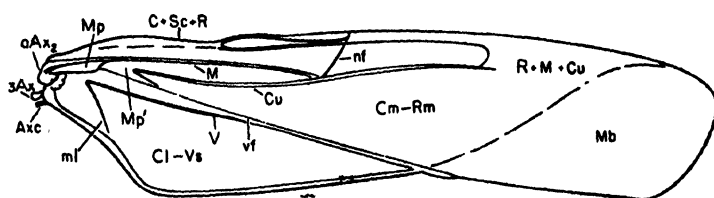


FIG 49

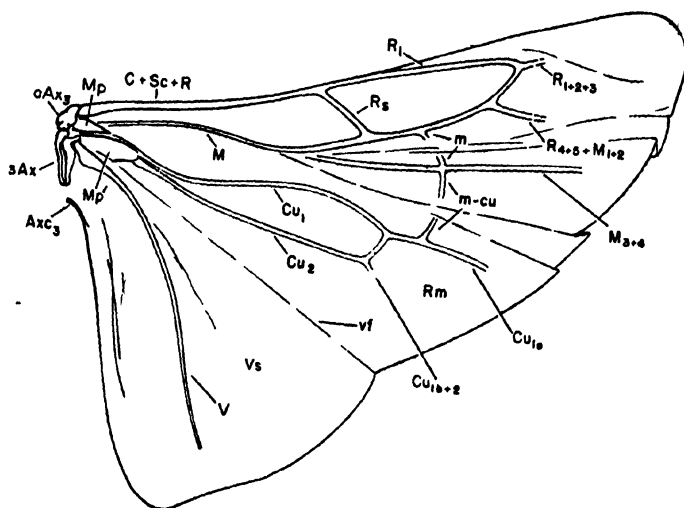


FIG 50

PLATE XXVII

FIG. 51. Dorsal view of female abdomen.

FIG. 52. Ventral view of apex of female abdomen.

FIG. 53. Ventral view of female genital capsule.

FIG. 54. Diagram of partial cross-section of fourth abdominal segment
(*Arctocoriza sp.*).

PLATE XXVII

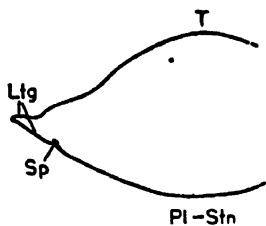


FIG. 54

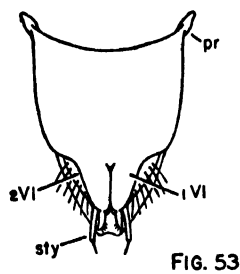


FIG. 53

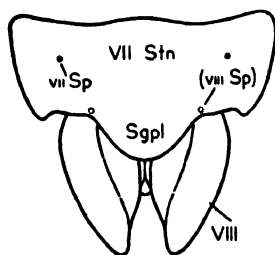


FIG 52

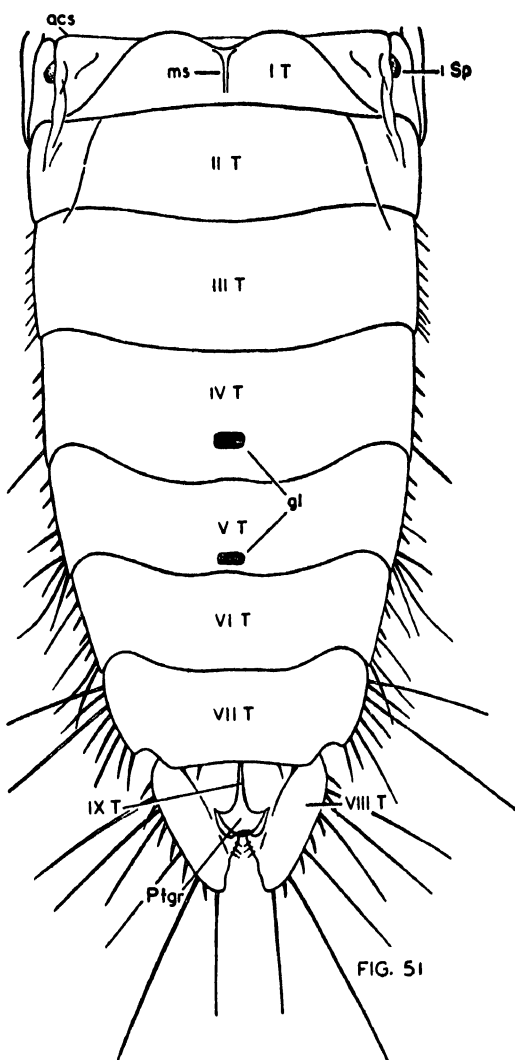


FIG. 51

PLATE XXVIII

FIG. 55. Dorsal view of male abdomen

FIG. 56. Ventral view of male abdomen.

FIG. 57. Dorsosinistral view of male genital capsule.

FIG. 58. Ventrodextral view of male genital capsule.

PLATE XXVIII

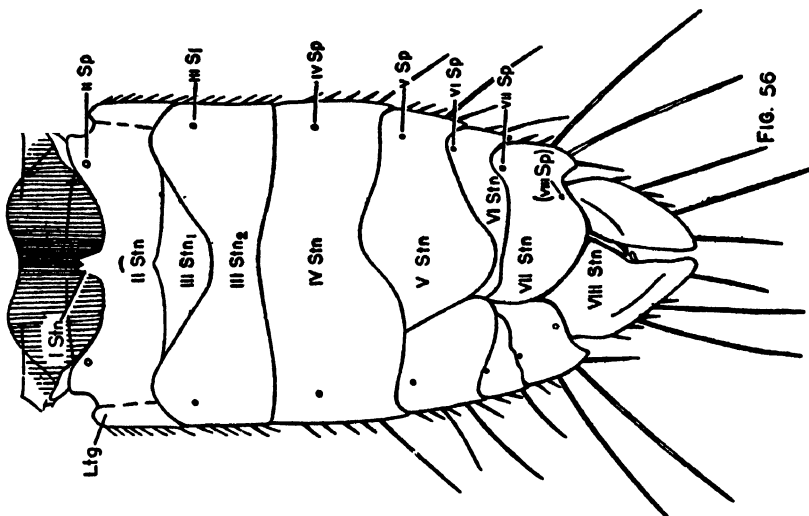


FIG. 56

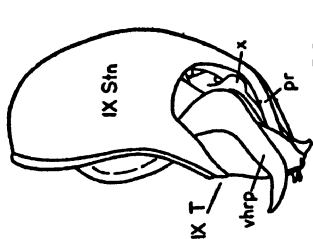


FIG. 58

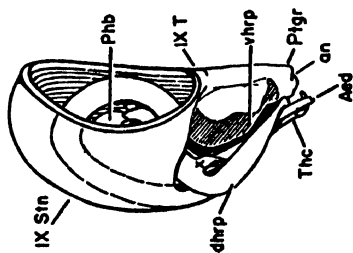


FIG. 57

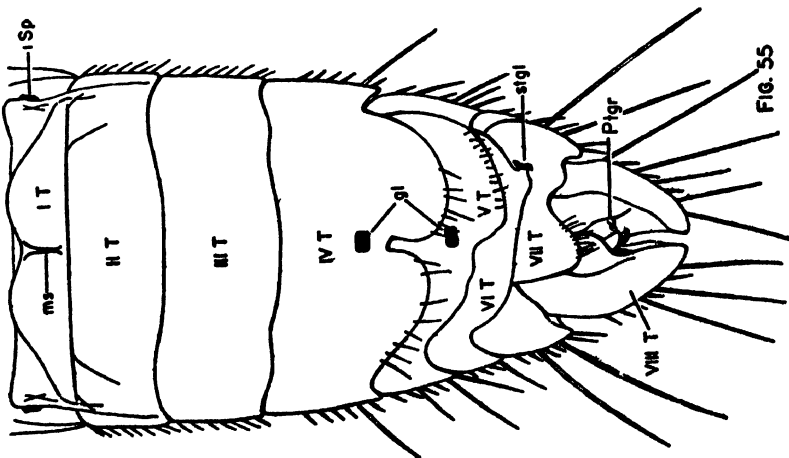


FIG. 55

THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

VOL. XXX, pt. II.]

JUNE 15, 1945

[No. 15

Revision of Nearctic Bibionidae Including Neotropical *Plecia* and *Penthetria* (Diptera)*

By D. ELMO HARDY

ABSTRACT: A monographic study of all the known Nearctic species of the Dipterous family Bibionidae, including the Neotropical *Plecia* and *Penthetria*, bringing up to date the taxonomy and known data concerning these flies. Keys to the genera of the New World and keys to species as follows: *Penthetria*, New World species based upon males; *Plecia*, New World species based largely upon males; *Bibio*, keys to both males and females; *Bibiodes*, key to species; *Philia*, keys to both males and females. New species: *Penthetria appendicula*, *distincta*; *Bibio albipennis beameri*, *carolinus*, *townesi*; *Philia tingi*. Nomenclatorial changes: *Bibio carolinus*, n. n. for *B. aser* McAtee; *Bibio neojacobi*, n. n. for *B. jacobi* Hardy (nec Villeneuve); *Plecia confusa* Loew for *P. ruficollis* Fabr. 1805. Synonymy: *Dilophus* Meigen syn. of *Philia* Meigen; *Eupeitenus* Marquart syn. of *Penthetria* Meigen; *Penthera* Philippi syn. of *Plecia* Wied.; *Rhinoplecia* Bellardi syn. of *Plecia* Wied.; *Spodius* Loew syn. of *Hesperinus* Walker; *Bibio currani* Hardy syn. of *Bibio bryanti* Johnson; *Bibio currani* var. *nigrita* Curran syn. of *bryanti* var. *nigrita* Curran; *Bibio fumidus* Coquillett syn. of *inaequalis* Loew; *Bibio fuscipennis* Macquart syn. of *femoratus* Wied.; *Bibio hirtus* Loew syn. of *albipennis hirtus* Loew; *Bibio humeralis* Walker syn. of *xanthopus* Wied.?; *Bibio jacobi rufitibialis* Hardy syn. of *neojacobi rufitibialis* Hardy; *Bibio lacteipennis* Curran (nec Zett) syn. of *bryanti* Johnson; *Bibio lucens* Hardy syn. of *nigripilus* Loew; *Bibio lugens* Loew syn. of *xanthopus* Wied.; *Bibio macateei* James syn. of *xanthopus* Wied.; *Bibio obscurus* Loew syn. of *xanthopus* Wied.; *Bibio pallipes* Say syn. of *abbreviatus* Loew?; *Bibio scita* Walker syn. of *xanthopus* Wied.?; *Bibio senilis* Wulp syn. of *femoralis* Wied.; *Bibio signatus* Hardy syn. of *xanthopus palliatus* McAtee; *Bibio simplicis* Curran syn. of *inaequalis* Loew; *Bibio tenuipes* Coquillett syn. of *albipennis tenuipes* Coquillett; *Bibio thoracica* Say syn. of *rufithorax* Wied.; *Bibio variabilis* Loew syn. of *nervosus* Loew; *Penthetria costalis* Walker syn. of *nigerrima* (Bellardi); *Penthetria longipes* Loew syn. of *heteroptera* (Say); *Philia dimideatus* Loew syn. of *spinipes* (Say); *Philia occipitalis* Coquillett syn. of *breviceps* (Loew); *Plecia flavimaculata* Hunter syn. of *flavimacula* Walker; *Plecia funebris* (Fabr.) syn. of *plagiata* Wied.?; *Plecia heteroptera* Macquart syn. of *plagiata* Wied.; *Plecia minor* Jaenicke syn. of *similis* Rondani; *Plecia rostrata* Bellardi syn. of *rostellata* Loew; *Plecia thoracicus* Say syn. of *spinipes* (Say); *Plecia velutina* Macquart syn. of *maura* Walker; *Plecia vittata* Bellardi syn. of *plagiata* Wied.

* Part II of the thesis submitted to the Department of Entomology and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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INTRODUCTION

SINCE McAtee's monograph of the Bibionidae¹ comparatively little attention has been given to this family in America. Doctor M. T. James, Doctor C. H. Curran, Mr. W. L. McAtee and the writer have made contributions to the literature since that time, a good many species have been added and many systematic changes have been made, so that a revisional study of this group is now badly needed. The foundation work on American Bibionidae was done in the early part of the nineteenth century by Say, Macquart, Loew, Walker, Fabricius, Wiedemann and Jaenicke and many of the types of the early species have been lost or are not at the disposal of American workers; consequently a good many of these have been difficult if not impossible to place. The earlier descriptions, for the most part, are very inadequate and do not present substantial specific characters. While making this study the writer has examined all of the available types of New World species and has had specimens compared with types in European museums whenever possible. The types of some species have not been located and accurate placement of these is questionable.

The Bibionidae are almost world wide in distribution, some genera such as *Plecia*, *Philia* and *Penthetria* are more abundant in the tropics and but poorly represented in temperate climates, while species of *Bibio* are numerous in temperate regions, and rather rare in the tropics. The genus *Bibiodes* is apparently confined to North America and *Bibionellus* is known only from Bolivia. The geographical regions of South and Central America contain very interesting species complexes, various species of the genus *Plecia* appear to be especially restricted in their distribution.

In position the Bibionidae stand between the Mycetophilidae and the Scatopsidae. For some time the latter were included in the family Bibionidae; this accounts for Malloch's *Forbesomyia*² being described as a Bibionidae. Enderline³ separated the two families in 1912 and Melander⁴ in 1916 applied the separation to the American species but neglected to treat *Forbesomyia*, which is distinctly a Scatopsidae. Alexander's *Cramptonomyia*⁵ has been placed in the Pachyneuridae, along with its closest relative, the *Pachyneura*. The

1. 1921, Proc. U. S. Nat. Mus. 60, 1-27.

2. 1913-15, New genus of Bibionidae, Bull. Ill. State Lab. of Nat. Hist. Vol. X, pp. 233-5.

3. 1912, Zur Kenntnis der Zygophthalmen. Zool. Ans. XI, 261-82.

4. 1916, Bull. 130, State Coll. Wash. Agri. Expt. Sta.

5. 1931, New genus of Bibionidae. Bull. Brooklyn Ento. Soc. Vol. XXVI, 7-11.

genus *Hesperinus* approaches rather closely some of the Mycetophilidae, but the presence of the complete second basal cell of the wing and the lack of well-developed spurs of the posterior tibiae places it as a primitive Bibionidae. The genus *Eupeitinus* Macquart⁶ is obviously the same as *Penthetria* Meigen, as is discussed in the synonymy under *Penthetria*. The name *Eupeitinus* has been used by Van der Wulp⁷ when he identified *Eupeitinus atra* Macquart from Wisconsin and by Walker⁸ who referred two specimens to this species; this is obviously a synonym of *Penthetria heteroptera* (Say). Coquillett⁹ reestablished the genus, but McAtee¹⁰ stated that the species used by Coquillett belonged to a new genus (*Axymia*) of Tipulidae. The genus *Axymia* has since been placed in the family Anisopodidae. Enderline¹¹ recently keyed the genera *Axymia* and *Pachyneura* as Bibionidae, but this is either an error or a difference in interpretation of the family limitations.

ECONOMIC IMPORTANCE

Several species of Bibionidae are considered major pests in various parts of Europe and the Far East, and perhaps further investigations of the life histories of our American species may prove them of more significance than normally considered. Because of the diversity of feeding habits of the larvae and their occurrence in such enormous numbers in local areas they may be potential pests of quite a wide range of crops. The larvae, for the most part, feed on decaying organic matter and upon roots of grasses and other plants and they most commonly occur in manures, in decaying leaves, in other plant materials and in grassy meadows and pasture lands. Many species appear to be omnivorous in feeding habits and may feed as scavengers, later changing to living plant tissues. It is probable that in many instances where the larvae have been found doing damage they have been carried to the plants in fertilizer. Severe infestations have been reported following heavy applications of manure or humus to the soil.

The information concerning the economic status of our American species is very meager and it is entirely speculative as to their actual importance. There have been numerous reports of their injurious

6. 1838, Dipt. Exot. Vol. I, pp. 84-5.

7. 1869, Tijds. V. Ent., Vol. 5, p. 80.

8. 1848, List of Dipt. in British Mus. 1.

9. 1909, Re-discovery of the Bibionid Genus *Eupeitenus*, Ent. News, V. XX, No. 3, p. 108.

10. 1931, Description of a New Genus of Nemocera (*Axymia furcata*). Proc. Ent. Soc. of Wash. Vol. 23, p. 49.

11. 1936, Dipt. Tierw. Mittel. VI.

activities and many observations have been recorded which suggest that they may be injurious. Damage to celery, wheat and potatoes has been reported from Alberta, Canada, by Strickland.¹² He states: "In 1914, when the celery was dug on October 24th, it was found that the soft pulp between the fibrovascular bundles of the stalks had been eaten away to an average depth of 1.5 mm. ($\frac{1}{16}$ inch). The work of the individual larva does not extend for more than about one-fourth inch between two of the vascular ridges. A large number of larvae swarm around infested plants, however, so that the whole of the portion of the plant which is below ground—some nine inches in length— may be affected. Towards the base of the plant, damage is most severe, and the excavations are often confluent, extending for two or three inches in length between the ridges, . . . Rarely the larvae burrow deeply into the pulp thus forming small tunnels, . . . The attacked areas turn brown during the late summer and autumn and are the seat of infection for various fungus diseases and small dipterous larvae, such as *Drosophila* which soon render the plants unfit for the market."

The damage to wheat in Canada occurred usually before the plants had sprouted above the ground, but sometimes the attacks occurred after they were well above the ground. Concerning the potato damage in Canada, Professor Strickland stated in correspondence that the larvae were found in very large numbers in a potato patch near Edmonton: "Insofar as I could judge the potatoes had been damaged by wire worms and the larvae had entered in this manner, but they were sufficiently numerous to entirely hollow out some of the tubers." Several reports of potato injury have been made, for instance, the writer has observed rather severe damage done by *Bibio melanopilosus* Hardy larvae in gardens at Spanish Fork, Utah.

There are occasional reports of injury in vegetable gardens, in grain fields and to forage crops, but most of these are entirely unconfirmed by experimental data. It is not at all uncommon to find the adults emerging in enormous numbers from fields of grain, potatoes, alfalfa, and other crops, but it is seldom that any actual damage is evident. To date, however, no checks have been set up to obtain a direct comparison between infested and noninfested plots.

In Europe Bibionidae are occasionally destructive to cereal and other crops. Experiments have shown that the larvae prefer barley, rye, sugar beets, and hops to all other plants. *Bibio hortulanus*

Linnaeus (Die Gartenhaarmücken) is no doubt the most important economic species. This fly has at various times been reported doing serious damage to crops in Germany, Denmark, Bavaria and Poland. Maier¹³ in 1936 reported losses of ninety percent of the rye crops in fields near Berlin and other parts of Prussia due to this pest. He states that the injury usually occurs in spring just after the cereals have sprouted but sometimes occurs after the crop is several inches high. The *Bibio* larvae were found to work about two inches below the surface and attacked the stems below the first node. His observations showed that fields in high areas were most frequently attacked and in all cases were near woods. Muller¹⁴ found that *B. hortulanus* females oviposited under crop remnants on beet and potato fields and the larvae fed on potato tubers, sugar beets, garden plants and especially germinating cereals. Sugar beets are subject to severe injury in Western Europe and the young shoots of the beet seedlings are sometimes entirely eaten.

Aside from these crops the larvae have been reported attacking the roots of oats, wheat (in many instances the damage being so severe that the fields had to be plowed up and resown), lettuce, seedling cabbage, grasses, young flowering plants, tomatoes, young conifers, seedling ash, larch, spruce and other nursery stock as well as forage crops, pasture lands and bowling greens. Morris¹⁵ estimated that 32.5 percent of the insect population of the permanent pasture lands of Cheshire, England, were Bibionidae larvae; a population of almost 1,200,000 individuals per acre.

Adult Bibionidae have been reported doing damage to blooming fruit trees, but this seems rather absurd and there is no actual evidence to this effect. Field observations and study of their mouthparts seem to contradict this, and on the contrary, they are probably beneficial in distributing pollen. They are thought to feed upon juices of plants. Sabrosky¹⁶ states, that he has observed *Bibio painteri* James feeding in association with the Chrysomelidae beetle, *Gastroidea cyanea* Melsh. He reports that "numerous Bibionids had their mouthparts appressed against the freshly cut edges of the leaves (cut by the beetles), apparently sucking the plant juices." This is one of the few observations that have been made of the actual feeding habits of the adults.

13. 1936, Nachr. Bl. dtseh. Pfl. Sch. Dienst. 16, 10.

14. 1930, Ueber Die Lebensweise und Bekämpfung der Gartenhaarmücken. Fortschr. Landw. 613.

15. 1920, Ann. Appl. Biol.

16. 1935, Jour. Kan. Ent. Soc. No. 4, 145-6.

CONTROL MEASURES

The best recommendations for prevention of Bibionid injury seem to be to remove all debris from the fields and to plow deeply in the fall and again before spring planting. When the eggs or larvae are turned under, the adults are unable to reach the surface and those that are turned up will die of exposure or be eaten by birds. In areas where infestation is common the use of artificial fertilizers instead of natural manures seems to be the most practical measure. Many recommendations for traps and use of chemical poisons and repellents have been made by various writers, but most of these would not be practical unless infestations were severe. Robek¹⁷ recommends placing slices of potatoes on end in the soil as attractants for the larvae. After three or four days these slices are then removed and thrown into hot water. Other traps are by means of old roots buried in the soil and dug up early in March when the larvae are feeding on them. Vassiliev¹⁸ states that the adults may be captured in great numbers in fermenting molasses. Molz¹⁹ says that potato skins steeped in a one percent solution of arsenious acid give an attractive and effective poison bait. Goidanich²⁰ has reported that complete protection for seed potatoes is obtained by dipping them in a one percent suspension of lead arsenate in water with addition of thirty percent gypsum. Sudeikin²¹ has recommended spraying infested land with a solution of chili saltpeter in early spring, and harrowing in autumn or early spring after spreading quicklime on the field. Hornik²² reports that a 1-2 percent spray of tobacco extracts containing 7 percent nicotine sulphate applied to the soil at about 55 gallons to the acre killed 42-52 percent of the larvae as compared with a 6 percent death rate in untreated soil. Bovien²³ states that the most effective control measure is to dust the manures and leaves with chemicals such as arsenicals and lime. Abraham²⁴ reports that excellent results were obtained by using calcium cyanamide as a top dressing at the rate of 180 to 280 pounds per acre and that the young plants were unharmed. (This procedure certainly would not be practical under ordinary field conditions.)

17. 1930, Muchnice dubnova. *Ochr. Rost.* X, No. 3, 73-74.

18. 1915, *Herald of Sugar Industry*. Kiev. XVI, No. 22, 511.

19. 1920, *Zeitschr. Angew. Entom.* VII, 92-96.

20. 1933, *Un. Nuovo metodo di difesa delle Patate da Semina Contro il. Italia Agric.* LXX, No. 2, 183-186.

21. 1913, *Pests of Agri. Plants in Gov't of Voronezh*. pub. by Zemstvo, Voronezh.

22. 1931, *Ochr. Rost.*, XI, No. 3-4, 115-120.

23. 1932, *Tidskr. Plantenvl.* XXXVIII, 468-498.

24. 1936, *Nachr. Bl. dtach. PflSchDienst*, 16, No. 2, 22.

Theobald²⁵ states that vaporite and injections of carbon bisulphide into the soil gave a satisfactory kill. Maier²⁶ applied a top dressing of potash to drive the larvae to lower depths "but no definite estimate of the value of this measure could be made because of subsequent frosts." Boning²⁷ found that the larvae of *B. hortulanus* L. were very resistant to damp soils and water immersion, making the older recommendation of flooding lands an impractical control method. He states that the larvae survived a twenty-four-hour immersion in water without apparent injury. They died in two to three hours when exposed on a hard surface in the dry air but lived for two days in quite dry soil.

BIOLOGICAL CONTROL

Robins, pheasants, poultry, starlings, chaffinches and rooks et al. have been reported by various authors to feed upon Bibionidae, and insectivorous birds are no doubt instrumental in keeping them in check. Lyonet²⁸ reported finding a mite on a Bibionid and a filarial worm inside one. Keilin²⁹ reported a Gregarine, *Schneideria mucronata* Leger, occurring in the mid-gut and anterior caeca of Bibionid larvae together with a bacterial disease. Morris³⁰ reported a *Schneideria* in the posterior caecum of a *Philia febrilis* Linn. larva, and two cysts full of spores were found free in the body of the same larva. Another parasite, probably a *Glugea*, was found infesting the epithelium of the alimentary canal of *Bibio johannis* Linnaeus; such a *Microsporidian* was mentioned in Keilin's paper invading the epithelial cells of the mid-gut and caeca of Scatopsid larvae. Morris described the larva and pupa of a Phoridae (*Hypocera incrassata* Mg.) parasite of *Bibio marci* Linn. The Plantesygdromme i Danmark³¹ states that *Bibio ferruginatus* Linn. and *B. hortulanus* Linn. had been causing injury to barley and that they suddenly disappeared; studies at this time showed up to 100 percent of the larvae to be parasitized by a Diapriid (*Spilomicrus* sp.). Malloch³² mentions a hymenopterous parasite, but the host relationship was questionable. Adrianov³³ reports the larvae of *Agriotes* (Elateridae) killing *Bibio marci* L. larvae.

25. 1909, Journ. of Board of Agri., Oct., 567.

26. 1936, Nachr. Bl. dtach. PflSchDienst, 16, No. 1, 10.

27. 1931, Pra Kt. Bl. Pflanzenbau u. Pflanzenschutz, IX, No. 7-8, 145-160.

28. 1882, Recherches sur les Insects (Mem. Peath.).

29. 1919, Ent. Monthly Mag. (3) v.; 92-96.

30. 1921, Bull. of Ento. Res. XII, 231.

31. 1932, Tidsekr. Planteavl. 39.

32. 1917, Bull. Ill. State Lab. of Nat. Hist. XII.

33. 1914, Report of Pests of Field Crops, pub. by the Zemstvo of Gov't of Kaluga, 67-88.

WING VENATION

The interpretation of the wing veins is the same as that used in Dorilaidae, however, the venation is much more generalized. The subcostal vein is weak in most genera and often ends before the wing margin. R_1 and $_2$ are fused and in higher genera R_3 and $_4$ are also apparently fused in the first branch of radius. The genera *Hesperinus* and *Penthetria* show the more primitive position of vein R_{3+4} , in a more horizontal position and forking off from the distad portion of the posterior branch of radius. *Penthetria appendiculana* sp. possesses a stub of a vein just above the forking off from the main stem (fig. 122c) which probably represents a remnant of the base of R_3 , suggesting that it originally forked off from vein R_2 . In the genus *Plecia* R_{3+4} has moved cephalad and is more vertical in position, approaching vein R_{1+2} . In *Plecia incurvata* Hardy the tip of R_{3+4} fuses with R_{1+2} (fig. 147b). In higher genera vein R_{3+4} has apparently migrated basally and disappeared in the axil of the radial sector, fusing with R_{1+2} or dropping out entirely. This basad migration is easily traced from the Bibionidae through the Mycetophilidae and Blepharoceridae. Vein R_1 is simple and in the genus *Bibiodes* (fig. 205c) this vein joins with media for a short distance, obliterating the r-m crossvein. Media is three branched, the portion interpreted as m-cu crossvein by Comstock-Needham is now known as the base of M_{3+4} and the base of Cu_1 of Comstock-Needham is the m-cu crossvein. Cu_1 and first A are usually strong veins and often converge at their apices so that the cubital cell is narrowed in the wing margin.

FEMALE REPRODUCTIVE SYSTEM

The following is the information gathered by dissection of the reproductive system of *Philia orbatus* (Osten Sacken). The gravid females have the entire abdomen filled with eggs and each ovary contains two to several hundred eggs. All of the eggs are of approximately the same size and are deposited in one mass at a single oviposition. From ventral view the eggs are usually in two main rows, from dorsal view most of the eggs are seen in end view and are arranged in several transverse rows, those in the posterior portion of the ovaries are usually lying flat and pointed toward the oviduct. No distinct ovarioles are visible and the lateral oviducts are very short with the common oviduct extending anteriorly about one-third the length of the ovaries. From all appearance the eggs are emptied directly into the common oviduct which opens into the

genital cavity of the eighth segment. The spermathecae are triple, conspicuous, large and black and branch off from the ventral portion of the median oviduct posterior to the ovaries. The accessory glands are distinctively shaped, green in color and attached to the ventral side of the common oviduct (fig. 110a). The eggs in about the middle of the ovaries enter the oviduct first, small end of egg pointed posteriorly, then the others are released in a sequence according to their natural position.

OVIPOSITION

Copulation usually takes place about twelve hours after emergence and the gravid female soon begins looking for a suitable place to oviposit; she flies very slowly with some difficulty, usually spending much of her time near the ground in grasses and weeds. The average length of life appears to be about three days, the male usually dies shortly after copulation and the female after oviposition. In studying oviposition habits gravid females are confined in cages or cloth covered glass jars in which has been placed a few inches of moist earth. The female then selects a suitable spot and begins digging out a burrow by means of the fossorial spurs of her front tibiae. The tarsi fold back and the fly digs by moving the front legs up and down in front of her head, scraping out the earth until the hole is large enough for her body, then she squeezes into it and gradually works downward to a depth of one to four inches. At the bottom of this burrow the fly enlarges the chamber and deposits her egg mass. After oviposition the female appears entirely exhausted and soon dies, usually never leaving the burrow.

EGGS

Each egg mass ordinarily contains two to three hundred eggs, these are cylindrical, oblong, rounded on each end and larger on one end. When first laid the eggs are pale whitish to faintly yellowish, but slowly turn darker, especially at the ends, as they grow older. The eggs are faintly shining and microscopically sculptured, being covered with very minute projections. The sculpturing of the chorion may show specific characteristics if studied in detail. The eggs are .50 to .90 mm. in length, and .10 to .20 mm. in width, depending upon the species. Under laboratory conditions the eggs of *Bibio* hatch in twenty to forty days, depending, of course, upon the season. Most all of the eggs hatch at approximately the same time and the larvae develop at an even rate, accounting for the sudden large swarms of adult flies which appear in the spring. The length of the incubation period varies with the species and with the ecological conditions.

LARVAE

The earliest description of a larva and pupa of *Bibio* was that of Reaumur.³⁴ This early work figures and describes the larvae and pupa of *Bibio marci* Linnaeus. "St. Marks fly." The earliest work encountered in America is the account by Kellogg, 1893, Trans. Kan. Acad. Sci. which discusses the larvae and pupae of *B. tristis* Williston and the account by Needham³⁵ of *Bibio fraternus* Loew, in which he describes and figures the larva and pupa. The paper by Girault³⁶ is also commendable and gives some very valuable observations on the life history of the March fly. The contributions of H. M. Morris^{37, 38, 39} on the immature stages of English Bibionidae are by far the best works on this subject.

The first instar larvae of *Bibio* vary in length from 1.3 mm. to 1.8 mm. The head is comparatively large and more heavily sclerotized than the rest of the body. The trunk is divided into twelve distinct segments, each segment, as well as the head, bearing numerous long setae on all first instar *Bibio* that have been recorded. The first instar larvae of *Philia* differ from *Bibio* in having only short setae. The larvae are pale yellowish in color, with the contents of the alimentary canal usually plainly visible through the integument as a dark median line. The body is cylindrical in shape and usually slightly curved. From all observations that have been made the first instar larvae bear but a single pair of spiracles, these are situated on the twelfth segment of the trunk. *Bibio johannis* Linnaeus required nineteen days, under laboratory conditions, before moulting to the second stage according to Morris.⁴⁰

With the first moult the larvae lose all of the long setae on the body and develop characteristic microscopic scalelike spicules on the cuticula. The head of the second instar is not so proportionately large as in the first. The full grown larvae vary from six to twenty-eight millimeters in length, according to the species. • The head is protruded, barely longer than wide and shining brown, darker, more strongly sclerotized than the trunk. The anterior portion of the head is darker in color and bears several strong setae, the hind portion is lighter brown and bare, capable of being retracted into the first segment of the trunk. Eyes are lacking and the antennae are

34. 1741, *Memoires des Insects*, 5; 70.

35. 1902, *American Naturalist*, vol. XXXVI, 181-185.

36. 1905, *Can. Ent.* 37; 822.

37. 1917, *Ann. of Applied Bio.* IV, 91-114.

38. 1921, *Bull. of Ento. Research*, XII, 221-232.

39. 1922, *Bull. of Ento. Research*, XIII, 189-195.

40. 1917, *Ann. Applied Bio.* IV, 94.

small and setiferous. The mandibles are strong and heavily sclerotized; the number of the teeth appears to vary in different species and the shape of these structures may prove of taxonomic importance. The inner surface of each mandible possesses a characteristic clump of fine long hairs near its median portion (fig. 111a). The maxillae are short and stout and bear numerous strong spinelike setae at the apices of the palpi and the endite lobes of stipes (fig. 111b). The labium is quite characteristic in different species, the mentum is usually about one and one-half times the width of the submentum, slightly concave on apical margin and lighter in color, less heavily sclerotized than the submentum. The submentum is rather dark in color with a lighter median area and a small clump of short spines in the distal portion of this pale area. The apex of the submentum is slightly to deeply concave, reaching almost to the distal margin of the mentum in some species and much beyond in others. The labrum is divided into two lobes by a median indentation at the apex, the distal portion is armed with short, stout tooth-like spines while the under portion is thickly covered with short closely set setae.

The body of the mature larva is subcylindrical, slightly flattened dorsoventrally with a slight downward curvature of the body as seen from lateral view. The trunk is distinctly twelve segmented, the first segment is the longest and sometimes may appear partially divided, but as Morris has pointed out, the imaginal disks prove it to be a single segment. The body possesses ten pairs of spiracles, a pair being located on all segments of the trunk except two and eleven. The spiracles are usually darker in color than the rest of the integument and may be partially protruded. The posterior pair are two to four times as large as any of the other spiracles, they are more dorsal in position and appear to have two or more openings. The other spiracles are laterally placed and each has just a single opening. The first pair is located toward the posterior margin of the segment and is larger than the others (except twelve), while those of segments three to ten tend to be situated nearer the anterior margins. The integument is covered with characteristic rows of spines and processes as well as microscopic scalelike spicules. These spicules are of varying sizes and shapes and from the little investigation that this phase has received it would appear that these may represent specific characters for distinguishing the larvae. The spicules differ chiefly in the number and position of the short, sharp pointed spines which they bear, or as in the case of *Bibio lacteipen-*

nis Zett. (fig. 112a) the lack of spines. In other species that have been studied the spicules have from one to seven or eight pointed processes (figs. 111c-120a). On most any larval slide it is possible to pick out spicules bearing different numbers of spines but the greater share of them tend to fit a specific pattern. Mr. P. C. Ting, San Francisco, Cal., has made investigations along this line and was the first to call it to the attention of the writer.

Concerning the digestive system of *Bibio marci* Linn. Morris states: "The alimentary canal takes an almost straight course through the body, but has a loop near the posterior end, in the hind gut. The largest part of the alimentary canal is the mesenteron, which bears three large caeca at its anterior end, one lying on each side and the third, which is the largest, places ventrally. The four malpighian tubes join the alimentary canal at the junction of the mesenteron and hind gut, entering the canal by a short common duct on the dorsal side. There is no posterior caecum such as is found in connection with the alimentary canal of *Bibio johannis*."

PUPA

The pupae are rather long and slender, slightly tapering toward the posterior portion, the cuticle is pale white, smooth and transparent in the newly formed pupae, the darker parts of the head and thorax showing plainly through the integument; the abdomen remains pale in color until after emergence. The females are usually larger in size and may be distinguished from the males by the small eyes and more abruptly narrowed anterior end. The large, slightly protruded eyes of the male will characterize this sex as in the adults. The anterior portion of the pupal case is often armed with small projections. The head is pressed down flat against the anterior part of the thorax and the short antennae are extended laterally over the eyes. The thorax is short and the legs and wing cases are closely pressed together on the venter. When the adult emerges the mesonotum splits down the longitudinal ridge at the middle of the dorsum allowing the fly to escape. The pupal stage requires approximately two weeks for the species which have been studied.

MALE GENITALIA

The genital structures of the male Bibionidae are very important taxonomically, especially in genera other than *Bibio*. In the *Plecia*, *Penthetria* and *Philia* the genital characters serve as the only criteria for separating many of the species. The characters that are most useful in the systematics of the family are: The depth and shape

of the cleft on the posterior margin of the ninth sternum or the general shape of the entire sclerite; the lateral margins may be strongly or weakly produced and the posterior margin is sometimes strongly developed. The degree of concavity or convexity of the posterior and anterior margins of the ninth tergum and the relationship of the length of sclerite to its width. The shape and development of the harpagones is usually distinctive for the species and all degrees of specialization are seen in these structures throughout the family. In the genus *Philia* the exact shapes of the harpagones are sometimes difficult to discern, giving rise to various interpretations according to the angle from which they are viewed. It is especially necessary in the latter genus to relax the genitalia before the true relationship of the parts can be observed. The accessory structures of the aedeagus and the shape of the cerci are often of importance in distinguishing species.

FOSSIL BIBIONIDAE

The chances for Diptera of this kind being preserved would be very slight, their comparatively soft integument and the dissolution of chitin in the presence of moisture would prevent the fossilization of more than a representation of the forms. Because of this it is difficult to estimate the probable abundance on a basis of the specimens that have been fossilized. *Protoplecia* Handlirsch dates back to upper Liassic (Middle Jurassic) and represents the oldest known member of this family. There is some question as to whether or not this is properly placed and it possibly belongs to some related family and does not represent a primitive Bibionidae. Only a single species, *Bibio sereri* Massalonge is listed by Handlirsch⁴¹ from Eocene deposits, so these flies were either rare at this time or conditions were not favorable for fossilization. The Bibionidae apparently enjoyed their heyday in the middle and late Tertiary period. From the fossil evidence they must have been one of the most numerous groups of insects at that time. Bibionidae remains are very abundant in most Oligocene and Miocene deposits although they are not at all common in the Baltic Amber. These flies are among the most characteristic fossils of the Florissant shales and Creed formations of Colorado. Most of the fossil Bibionidae belong in present day genera and most of the species appear to approach our modern forms very closely, some may even be identical.

Freak individuals are rather common in the Bibionidae. It is not

41. 1908, *Die Fossilen Insekten*; 961.

at all unusual to find malformations of various appendages, especially the legs, or to find distortions of the head and body. Many specimens have been observed wherein certain leg joints have been atrophied, strongly bowed, or entirely lacking. James⁴² reports finding a gynandromorphic specimen of *Bibio monstri* James. Wheeler⁴³ records a specimen of *Philia tibialis* (Loew) with an antenniform appendage branching from the fore coxa.

SYSTEMATIC TREATMENT

The Bibionidae are readily distinguished from other Nematocera by the absence of the discal cell in the wing, the presence of the two basal cells, and the forking of the radial-sector at or beyond the m-cu crossvein. Ocelli present on a well developed prominence. Antennae (except in *Hesperinus*) rather short, with rounded compact segments, situated below the compound eyes close to the oral margin. Spurs of front tibiae of *Bibio*, *Bibiodes* and *Bibionellus* strongly developed. The front tibiae of *Philia* are ornamented with two or more sets of spines.

KEY TO THE GENERA OF THE NEW WORLD

1. Third longitudinal vein (main branch of radius) furcate..... 2
 Third longitudinal vein not furcate (posterior branch of radius simple); front tibiae
 with large apical spurs or two or more sets of spines..... 4
2. Antennae very elongate, third segment as long or longer than the next two segments.
 Hesperinus Walker, p. 382
 (Europe, North and South America)
- Antennae more robust, third segment not greatly lengthened..... 3
3. Vein R_{3+4} short, almost vertical, male harpagones usually small and vertical.
 Plecia Wiedemann, p. 390
 (Cosmopolitan)
- Vein R_{3+4} rather elongate, almost horizontal, harpagones large and lateral
 Penthetria Meigen, p. 384
 (probably world wide)
4. Anterior tibiae produced apically to form two spurs..... 5
 Anterior tibiae not produced at apices, but with two or more series of spines (fig.
 219a) *Philia* Meigen, p. 497
 (Cosmopolitan)
5. Third and fourth longitudinal veins coalesced for a short distance, obliterating r-m
 crossvein (fig. 205c)..... *Bibiodes* Coquillett, p. 491
 (North America)
- Third and fourth veins not coalesced, joined by the radio-medial crossvein (fig. 201a) 6
6. Front tibiae each with a conspicuous blunt tubercle in the middle beneath; costa
 greatly produced, reaching about halfway from R_5 to M_1 *Bibionellus* Edwards, p. 496
 (South America)
- Front tibiae without the mid-tubercles; costa ending at the tip of R_5 .
 Bibio Latreille, p. 444

42. 1936, Some New Western Bibionidae. Am. Mus. Nov. No. 332.

43. 1896, Arch. f. Entw. Mech. d. Org., V. 3, 26-108, pl. 16.

Hesperinus Walker

Hesperinus Walker, 1848, List of spec. of Dipt. Ins. in Coll. Brit. Mus. 1, 81.

Spodius Loew, 1858, Berl. Ent. Zeitschr. II, 101.

This is the most primitive genus of present-day Bibionidae, it is closely related to the Mycetophilidae in many respects. It is easily distinguished from all other genera in the family by its elongate antennae and the unusual developments of the male harpagones. The wing venation is very similar to *Plecia*, however, the cubital cell is more consistently open wide in the wing margin, vein Cu₁ scarcely curving downward at its apex.

In the Mycetophilidae the genera *Hesperodes* and *Platyura* are related to *Hesperinus*.

Genotype: *Hesperinus brevifrons* Walker.

Hesperinus brevifrons Walker

(Plate XXIX, figs 121 a-e)

Hesperinus brevifrons Walker, 1848, List of the specimens of Dipterous Insects in the collection of the British Museum, I, 81.

MALE.—Rather slender Bibionidae with long stiltlike legs and elongate antennae. Head and body brown to black with gray pruinose markings. Pile of the body very sparse, short and yellow, the thorax being practically devoid of pile, that of the abdomen more dense posteriorly. Palpi, trochanters, coxae, femora and stems of halteres ochraceous. The antennae, rest of the legs and knobs of halteres pale to dark brown. Antennae twelve segmented, first two segments (scape and pedicel) short; third segment longer than the next two; with rather dense pale pubescence and stronger black hairs intermixed, the latter usually arranged in whirls. Wings dusky hyaline, veins brownish-black, stigma lighter in color and more grayish, distance between anterior crossvein and fork of fourth vein twice the length of the crossvein (fig. 121a). *Genitalia:* This is one of the most interesting and distinctive structures (in Bibionidae) that has been examined by the writer. The unusual development of the clasping structures is really remarkable and no doubt is a generic as well as a specific character. The harpagones are developed into two large lateral arms (figs. 121c-d), the dorsal arm is developed into two projections; one is longer, more flattened laterally and the other is short and developed only about half way up the dorsal lobe on the underside. The cleft on hind margin of ninth sternum is U-shaped, narrowing down considerably at the base, extending nearly one third the length of the segment (fig. 121e). The ninth

tergum is gently concave on hind margin (fig. 121b). The entire genitalia is rather densely haired, these hairs are larger, more spine-like on the distal portion of the ninth sternum. The ninth segment is very noticeably swollen, being much larger than the other segments of the abdomen.

FEMALE.—Differs from the male in having the antennae much shorter but other characters are constant for both sexes, except the genital characters and the enlarging of the male abdomen.

Type locality: St. Martin's Falls, Hudson Bay.

Type in the British Museum.

McAtee reports specimens from Current Creek Valley, Uintah National Forest, Utah. As far as is known by the writer this is the only report for the state. Specimens have been examined from Lake City, Colo., 6-29-37 (C. L. Johnston); Alberta (Strickland), Alaska and New Hampshire.

Hesperinus flagellaria Garrett

Hesperinus flagellaria Garrett, 1925, Sixty-one New Diptera, Cranbrook Courier Print, p. 11.

The writer is unable to distinguish *flagellaria* from *brevifrons* Walker and the two are probably synonymous.

Following is the original description:

"MALE.—Dark brown except the sides of the back of the head, between the dorsal vitta, which are pale dull brown; antennae long, about as long as the abdomen, all yellow brown, 12 segmented, the scape short, cup shaped flagellum cylindrical, segment one very long, about 9 times the length of scape two, flag two less than half one, the rest gradually diminishing to the tip, each with two or three bristly hairs; palpi yellow and large; segment one small; two about equals four, and three half of their length. Wings hyaline, veins brown, stigma black. Hypopygium constructed much as in genus *Bibio* but larger, eyes bare, tibial spurs very small, legs long. Female similar but the antennae are shorter, only about as long as the thorax; flagellum one about 5 times scape two; flag two less than half of one, segment 8, 9, 10, 11 about as broad as long; 5 and 6 twice as long as broad. Palpi segment one very small, and three nearly equals the length of two which is equal to four."

Type locality: Cranbrook, B. C., Canada.

Type in Garrett Collection.

Penthetria Meigen

Penthetria Meigen, 1803, Illiger's Magaz. II, 264.

Eupeitenus Macquart, 1838, Dipt. Exot. Nouv. ou peu Connus I, 85.

Plecia spp. of many authors refer to this genus.

Entirely opaque black species, usually rather thickly covered with black hair, especially on sternopleurae, hypopleurae, upper portions of propleurae, legs and abdomen. Rostrum not greatly produced, much shorter than the length of antennae. Antennae eleven to twelve segmented. Legs long and slender, posterior tarsal subsegments somewhat swollen in the males of most species. Vein R_{3+4} horizontal or nearly so in position and elongate compared to *Plecia*, Harpagones lateral in position, rather large and conspicuous; for the most part the genital structures do not show great differentiation from a typical pattern.

The species of the genus are very much alike superficially and the genital structures must be relied upon for most specific determinations.

KEY TO NEW WORLD PENTHETRIA

(Based upon males)

1. Hind margin of ninth tergum straight or nearly so. (Mexico) *nigerrima* (Ballardi), p. 383
Hind margin of ninth distinctly concave or deeply cleft. 2
2. Ninth tergum deeply cleft on hind margin, the cleft extending at least two-thirds the length of the sclerite. 3
Cleft of ninth tergum not extending over one-third the length of the sclerite. 4
3. Vein R_{3+4} normal, without an appendix at base; ninth tergum almost completely divided into two plates by the deep clefts of the posterior and anterior margins, only a narrow strip of sclerite joins the lateral lobes (fig. 123a); harpagones rather short and broad (fig. 123b). (Guatemala) *distincta* n. sp., p. 385
Vein R_{3+4} with an appendix near base; ninth tergum not so deeply cleft (fig. 122b); harpagones slender, more elongate (fig. 122a). (Costa Rica) *appendicula* n. sp., p. 384
4. Cleft of ninth tergum broadly V-shaped, margins straight (fig. 125a).
(Mexico) *mexicana* (Hardy), p. 387
Cleft U-shaped, margins rounding. 5
5. Harpagones slender, acutely pointed; posterior median margin of ninth sternum developed into a pair of strong lobes; sclerotized portion above aedeagus with a small niche in middle (fig. 127a). (South America) *nigrita* Perty, p. 389
Harpagones more broad, square tipped; posterior median margins of ninth not produced; sclerotized portion above aedeagus terminating in a small blunt point in the middle (fig. 124a). (North America) *heteroptera* (Say), p. 386

Penthetria appendicula n. sp.

(Plate XXIX, figs. 122a-c)

This species differs from all known New World *Penthetria* in being more densely haired; vein R_{3+4} with an appendix at base; ninth tergum deeply cleft on hind margin and harpagones slender.

Entirely black, densely pilose species. Antennae eleven to twelve segmented, rostrum not greatly produced. Mesonotum rather thickly covered with long black hairs, scutellum bare or nearly so. Hum-

eral ridges very faintly yellowish tinged; propleurae each with a very dense patch of black hairs on upper portion; sternopleurae and hypopleurae thickly covered with long, thin hairs; sternopleurae finely rugulose and covered with fine yellow pubescence in addition to the long black hairs. All tarsi slender, posterior pair only slightly swollen, hind basitarsi almost equal in length to the next three sub-segments of tarsi. *Wings*: Lightly yellow-brown fumose, vein R_{3+4} with a strong appendix at its base (fig. 122c); stigma slightly darker than the wing membrane; the third, fourth and fifth costal sections are about equal in length. Fork of first and second medial veins situated well beyond the r-m crossvein; base of M_{3+4} about half the length of the m-cu crossvein; cubital cell slightly narrowed in the wing margin by the downward curve of vein Cu_1 . *Genitalia*: The ninth tergum is about twice as wide as long and deeply cleft, about two-thirds its length on hind margin (fig. 122b). Ninth sternum moderately concave in middle but with a membranous apex which makes the hind margin almost straight. Harpagones slender and rather elongate (fig. 122a).

Length: body, 8 mm.; wings, 9-9.4 mm.

FEMALE.—Aside from sexual characters the female differs in consistently having twelve segments in the antennae and the mesonotum less conspicuously haired.

Holotype male: Volcan Poas, Costa Rica, April 21, 1916 (A. Alfaro). Allotype female: La Carpentera, Costa Rica, April, 1924 (H. W. Atkinson). One paratype male, same data as holotype; two paratypes, one male, one female, same locality and date as allotype (W. M. Mann) and six paratype males, San Cristobal, Costa Rica, 5,400 ft., May 27, 1928 (F. G. Wallace).

Holotype, allotype and two paratypes returned to United States National Museum; three paratypes returned to the University of Minnesota, the rest retained in the Snow Entomological Collection.

Penthetria distincta n. sp.

(Plate XXIX, figs. 123a-b)

This species is related to *appendicula* Hardy but is distinguished by its dark fumose wings, lack of appendix at base of fourth vein, very deeply concave posterior and anterior margins of ninth tergum and shorter more broad harpagones; species not so thickly haired.

Antennae twelve segmented, wings brown fumose, stigma concolorous with the membrane; cubital cell widely open in wing margin, vein Cu_1 scarcely curved downward at its tip. All tarsi slender,

subsegments of hind tarsi but slightly swollen. *Male genitalia*: The ninth tergum is about twice as wide as long, densely haired and almost completely divided into two plates by the clefts of the anterior and posterior margins, only a narrow bridge of sclerite joins these two lateral plates (fig. 123a). The ninth sternum is moderately concave, the posterior lateral margins are rather strongly produced; these lobes are slightly undulated on outside margins. Harpogones broad, rounding apically (fig. 123b).

Length: body, 7-8.7 mm.; wings, 8-9.4 mm.

Female fits the above description except for sexual characters; the hind tarsi are, however, more slender, not at all swollen.

Holotype male: Antigua, Guatemala, June 24, 1923 (E. G. Smyth). Allotype female and five paratypes, four males, one female, same data as type (Smyth and D. G. Eisen); eleven paratype males, Guatemala City, Guat., May 2, 1923 (E. G. Smyth), two males, Agama, Guatemala (D. C. Eisen) and one male, Volcan Sta Maria, Guatemala (Schaus and Barnes).

Holotype, allotype and ten paratypes returned to the United States National Museum, others retained in Snow Entomological Collection.

Penthetria heteroptera (Say)

(Plate XXIX, figs 124a-d)

Bibio heteroptera Say, 1823, Jour. Acad. Nat. Sci. Phil. III, 78.

Penthetria atra Macquart, 1834, Hist. Nat. des. Ins. vol. I, 175.

Eupetennus ater Macquart, 1838, Dipt. Exot. Nouv. ou peu Connus. I, 85.

Plecia longipes Loew, 1858, Berl. Ent. Zeitsch. 2, 109-110.

E. ater Macquart was taken from a cabinet name of Serville but the original description was published by Macquart. There can be little doubt that this is the same genus and species which he had previously described as *Penthetria atra*.

P. heteroptera is distinguished from related species by the concave hind margin of the ninth tergum and the broad heavily sclerotized bridge behind the aedeagus.

MALE.—Opaque black, rather thickly black haired species. *Head*: Ocellar triangle very prominent; compound eyes divided into an upper and lower portion by a transverse depression near lower one-third to one-fourth of the eye. Antennae eleven segmented, including the knoblike tip segment. Rostrum not greatly produced, folded beneath the head in normal position. Mesonotum more sparsely haired, abdomen very densely pilose. Posterior femora and tibiae somewhat clavate, hind basitarsi slightly swollen and almost equal to next three subsegments of tarsi in length. Wings smoky brownish

to black, stigma black. The distance between the r-m crossvein and the fork of M_1 and M_2 is usually about equal to the length of Rs from r-m crossvein to fork of main branch of radius, these lengths may vary a good deal. Vein Cu_1 curved downward moderately toward its apex, somewhat narrowing the cubital cell. *Genitalia*: Thickly black pilose, ninth sternum cleft about one third its length on hind margin with a pair of moderate swellings medianly and a shallow broadly U-shaped cleft between these; these areas are developed into rather strong lobes in *nigrita* Perty. Harpagones slender and gently curved inward, somewhat square at apices, with a small acute point above. The genital chamber just above aedeagus is sclerotized and distinctive in shape, terminating in a blunt point medianly (fig. 124a). The ninth tergum is nearly twice as wide as long, with a broad U-shaped concavity on hind margin (fig. 124c).

Length: body and wings, 7-7.4 mm.

The female is more sparsely haired and specimens usually show more variation in wing venation. *Female genitalia*: The eighth sternum is completely divided into two plates by a narrow median membranous area, the posterior margin of these plates is developed into a large rounding lobe (fig. 124b). The hind margin of ninth tergum is straight or nearly so, the anterior margin is very deeply cleft so that only a very narrow strip of sclerite joins the two lateral lobes. Cerci elongated (fig. 124d); entire genitalia densely haired.

Type locality: Maryland.

Type probably lost.

This species is widely distributed in the Nearctic region north of Mexico; it has been identified from the following states and Canadian provinces: Colorado, Florida, Georgia, Iowa, Kansas, Louisiana, Maine, Manitoba, Maryland, Massachusetts, Michigan, Missouri, Nebraska, New York, North Carolina, Ontario, Ohio, Pennsylvania, Quebec, South Carolina and South Dakota.

Penthetria mexicana (Hardy)

(Plate XXX, figs. 125a-b)

Plecia mexicana Hardy, 1927, Proc. Utah Acad. Sci. XIV, 199.

This species is related to *nigerrima* (Bellardi) and to *heteroptera* (Say), it is distinguished from the first by the broadly V-shaped cleft on the hind margin of ninth tergum (fig. 125a), and by the lack of development of the hind margin of ninth sternum. It is distinguished from *heteroptera* (Say) by shape of the sclerotized portion above the aedeagus and by the broadly rounding harpagones.

Antennae ten segmented in male, pleurae and sternum of thorax

reddish black in ground color, metanotum faintly tinged on the margins. Humeral ridges yellowish brown. In all specimens examined the cubital cell has been closed, or nearly so at its apex. The posterior tarsal subsegments are slightly swollen but not so much as in *nigerrima*. *Male genitalia*: Ninth tergum much wider than long, the V-shaped cleft extending one-fourth to one-third the length of the segment. Ninth sternum moderately concave medianly, hind margin without strong median lobes. Harpagones broad, entirely curved and rounding apically (fig. 125b). Sclerotized portion above aedeagus shaped somewhat as in *nigerrima*.

Length: body, 7.2-7.6 mm.; wings, 7.4-7.8 mm.

Type locality: Guadalajara, Mexico.

Type in collection of H. J. Reinhard.

The writer has identified a series of toptotypes and specimens from Tamasopa, San Luis Potosi, Mexico, Dec. 4, 1909 (F. C. Bishopp).

Penthetria nigerrima (Bellardi)

(Plate XXX, figs. 126a-b)

Plecia nigerrima Bellardi, 1859, Saggio di Dit. Mes. I, 14-15.

Plecia costalis Walker (nec Wiedemann), 1858, Trans. Ent. Soc. Lond. V., 422. (Syn. by Edwards).

This species is related to *heteroptera* (Say) and is most conveniently separated by use of genital characters. The wings are most consistently yellow-brown fumose instead of blackish; the humeral ridges are usually yellowish tinged and the hind metatarsi more distinctly swollen, about equal in width to the tip of tibiae. The almost straight posterior margin of ninth tergum, the shape of the harpagones, ninth sternum and sclerotized portion above aedeagus will distinguish it.

Male genitalia: Ninth tergum wider than long, hind margin straight or nearly so (fig. 126b). Posterior median margin of ninth sternum developed into a pair of moderate lobes, harpagones broad and rounded apically. Sclerotized portion above aedeagus characteristically developed into a pair of slender lateral wings (fig. 126a).

The female genital structures compare with *heteroptera* (Say) except that the ninth tergum is divided into two lateral plates, not joined by a narrow strip of sclerite.

Length: body, 6.7-8 mm.; wings, 7.4-9.2 mm.

Type locality: Orizaba, Mexico.

Type at the Paris Museum.

The writer has studied topotypic specimens, also specimens from the following localities in Mexico: Mexico City (O. W. Barrett); Cuautla, June 3, 1922 (E. G. Smyth); Coapa D. F., Aug. 29, 1922 (E. G. Smyth); Hocomilco, April (W. M. Mann); Envir de Guadalajara, Estat de Jalisco, 1901 (M. Diguët); Cordoba, Dec. 17-Jan. 15, 1907-1908 (Fred'k. Knab).

Penthetria nigrita (Perty)

(Plate XXX, figs. 127a-b)

Penthetria nigrita Perty, 1880, Delectus Anim. Articularotum.

The description of *nigrita* is insufficient to positively identify the species, however, if Perty actually had a *Penthetria* before him there can be little doubt but that it was the common South American species.

Following is the original description:

"Aterrima, opaca; alis infuscatis, venis obscurioribus. Lg. 3".
Latit. alar. expans. 10¼".

"Habitat in Provincia Piauhionsi.

"Magnitudine et statura *Penthetriae holosericeae* Meig. cui valde affinis videtur, quam vero ipsam non vidi. Toto atra, opaca, abdominis dorso parum nitidulo. Alae praesertim ad basin, ubi venae concurrunt, infuscae, venis et membrana juxta vena obscurioribus. Halteres et pedes atri."

This species is inseparable from the North American *heteroptera* (Say) except by genital characters and geographic distribution. The median lobes of the ninth sternum are more strongly produced, the median cleft more narrowly U-shaped and deeper and the harpagones are more slender and acute at their apices; the sclerotized portion behind the aedeagus has a small incision at apex (fig. 127a). The ninth tergum is wider than long with a broadly U-shaped concavity on hind margin, extending about one-third its length (fig. 127b).

Length of male: body, 7.4-8 mm.; wings, 9-9.4 mm.

Length of female: body, 8-8.7 mm.; wings, 7.4-10 mm.

Type located in the Zoölogical Museum at Munich.

The writer has identified this species from the following localities in South and Central America:

Bolivia: Germain (Lichtwardt).

Brazil: Sao Paulo.

Colombia: ac. 33501 (Felipe Ovalle Q.); Bogota, March 25-June 21, 1934-1937 (Apolinar, Bequaert, Peterson, Osorro); Quatiquia

R., Villavicencio, Nov.-Dec. 1914 (Dr. A. Balfour); Guarini (Peterson).

Ecuador: El Angel, 3000 ft., 1903 (P. Rivet); Minza Chica, V. Tungurahua, 3750 M., 2-14-IV, 1939 (F. M. Brown); Pichincha Prov., 3000 M., XI-5, 1938 (F. M. Brown); Uyambicho, XI-18, 1938, 2700 M. (F. M. Brown); Tungurahua, Banos 1600-1900 M. (W. M. MacIntyre).

Peru: Huacapistana, Rio Tarma, 1-2, June, 1920 (Cornell University Exp. Lot 569).

Venezuela: El Junquito, D. F. Jan. 15, 1939 (G. V. Berthier).

Plecia Wiedemann

Plecia Wiedemann, 1828, *Aussereurop*, Zweifl. Ins., 1, 72.

Rhinoplectia Bellardi, 1859, *Mem. Roy. Ac. Sci. Torino* (2), 19, 216.

Penthera Philippi, 1865, *Verh. Zööl.-Bot. Ges. Wien*, 53, 603.

The species of this genus vary a great deal in color and size, from opaque black or cinereous to partially or chiefly shining rufous and from a body length of 2.1 mm. to 12.0 mm. Species usually rather sparsely haired on mesonotum and pleurae although some may be entirely covered with dense black pile. The rostrum, sclerotized portion of face below eyes, is short to greatly produced. In the subgenus *Rhinoplectia* the rostrum is developed about as long or longer than the length of the antennae. This character is considered of minor importance and several species such as *curvistylata* Hardy, *maura* Walker, and *seminitens* Edwards appear to be on the borderline between *Plecia* (*Rhinoplectia*) and *Plecia* (*Plecia*). The number of antennal segments varies from seven to twelve, the females often having one more segment than the males. The legs are slender, elongate, usually black and thickly haired. Wings hyaline to blackish fumose, the radial sector forks beyond the radio-medial crossvein, the anterior branch (R_{3+4}) is short and rather vertical in position. The best specific characters are found in the male genital structures. The shapes of the ninth tergum and sternum are distinctive. The female genitalia also show specific characters but just how diagnostic these are has not been thoroughly worked out; this is the first comparative study of the female structures that has been made.

This genus is allied to *Crapitula* and *Penthetria* but is distinguished by the wing venation and the position of the male harpagones. The short, almost vertical vein R_{3+4} and the more vertical harpagones will separate *Plecia*; the ninth segment and genital appendages show much greater differentiation than in the related genera.

While studying the *Plecia* the writer has examined large numbers of specimens from many geographical regions in South, Central and North America which fit perfectly the original descriptions of several apparently well founded species. These have always been placed with a query because of the noticeable generality of their definition and the wide geographical range over which they extend. The most notable in this group are *Plecia confusa* Loew, *P. rufithorax* Walker, *P. bicolor* Bellardi and *P. collaris* Fabr. *Plecia confusa* Loew was long known as *P. ruficollis* Fabr., Wiedemann identified specimens as this from Brazil. A few years later H. Loew stated that it was very unlikely that the South American species could be the same as that from Africa and proposed the name *confusa* for it. Since that time this name has been used to indicate those specimens having a short rostrum and the thorax entirely rufous, even including the North American specimens under this name. Study of the male genital structures through this series proved that it is actually a complex of many species; this has also proved to be the case in the *rufithorax*, *bicolor* and *collaris* groups. These important structures have received but little attention in the *Plecia* and this accounts for the "lumping" of well defined species.

The genus is almost world wide in distribution although the larger share of species are confined to the tropical regions. Only two *Plecia* (*americana* Hardy and *nearctica* Hardy) are known from America north of Mexico.

Genotype: *Hirtea fulvicollis* Fab., 1828, Auss. Zweifl. Ins. 1, 72.

KEY TO PLECTIA

(Based largely upon males)

1. Thorax polished, at least on the dorsum, sometimes with three to four shining vittae, or dorsum rufous and pleurae black 2
 Thorax subopaque to gray dusted, if subshining the notum is at least lightly pruinose, pleurae usually concolorous with dorsum 12
2. Mesonotum with three to four shining stripes which are distinctly separated by opaque or dusted longitudinal lines, usually black species 3
 Mesonotum not divided into stripes by opaque lines, usually at least in part rufous, 9
3. Wings smoky with a conspicuous pale yellow fascia across the middle; ninth sternum of male genitalia very large and extending around to the dorsal portion of the segment 3a *pictipennis* Edwards, p. 426
 Wings uniformly fumose or chiefly hyaline, ninth sternum not so developed 4
 3a. Stripes of mesonotum shining black *pictipennis pictipennis* Edwards, p. 426
 Shining stripes of mesonotum reddish *pictipennis rufovittata* Edwards, p. 427
4. Harpagones of male genitalia not bilobed 6
 Harpagones bilobed 5
5. Inner (lower) lobe of each harpago much smaller than outer and below it (fig. 160a). Harpagones slender from lateral view with only one lobe visible (fig. 160b); sternum with a U-shaped median cleft; median process of ninth tergum projected beyond posterior margin of segment *persimilis* Hardy, p. 424
 Inner lobe projecting on the same level or above outer, almost as strong; sternum with

a broad flat topped median development (fig. 174a). Harpagones broad from lateral view, both lobes visible (fig. 174b). Median process of tergum not so developed.

seminitens Edwards, p. 437

6. Three longitudinal stripes on mesonotum, middle stripe undivided; ninth tergum not cleft on hind margin (fig. 155a); harpagones broad.....*nitidicollis* Edwards, p. 420
Four stripes on mesonotum, median stripe divided by a thin gray line; harpagones more narrow 7
7. Rostrum developed twice as long as the antennae, much longer than the head; ninth tergum of male cleft almost half its length (fig. 166d).
(Mexico) *quadrivittata* Williston, p. 430
Rostrum little if any longer than the antennae; ninth tergum only slightly concave on hind margin and with a median process..... 8
8. Ninth tergum of male with a pointed median process, posterior lateral margins narrow (fig. 165a); harpagones long and slender (fig. 165b). (Some males of this species may run here, all females observed have been entirely opaque). *punctulata* Hardy, p. 429
Ninth tergum with a broad square topped median process, margins not produced (fig. 180d). Harpagones with a long, slender, inward projecting beak as seen from lateral view (fig. 180c).....*avicephalisforma* Hardy, p. 396
9. Dorsum of males chiefly shining black, thorax of females rufous; small species (body 2.1-3.5 mm.; wing 2.6-4 mm.) 10
Sexes not dimorphic, at least the dorsum chiefly rufous, larger species..... 25
10. Mesonotum finely shagreened, ninth sternum of male with a pair of blunt processes on posterior margin*rugosa* Hardy, p. 436
Not possessing the above characters, very minute species..... 11
11. Ninth tergum of males deeply cleft, dorsum of male entirely black, *edwardsi* Hardy, p. 408
Ninth tergum but slightly concave, margins of mesonotum of male rufescent.
rufimarginata Hardy, p. 433
12. At least posterior half of mesonotum yellow to rufous..... 39
Thorax chiefly black in ground color, at least on dorsum (*marginata* Edwards has a narrow border of orange on mesonotum and reddish pleurae and abdomen).....13
13. Thorax distinctly gray pruinose..... 14
Thorax subopaque to dull black, not distinctly grayed.....16
14. Ninth sternum of male developed into two long armlike processes on hind margin, harpagones median in position (fig. 164a).....*pruinosa* Hardy, p. 428
Not so developed 16
15. Ninth sternum concave in middle on hind margin, posterior lateral margins not developed (fig. 148a)*lateralis* Hardy, p. 413
Ninth sternum with a median development, posterior lateral margins produced (fig. 144a)*grisea* Edwards, p. 410
16. Wings yellow-brown to black fumose along the veins, hyaline in the middle of the cells 17
Wings more evenly fumose, not contrasting hyaline in middle of cells..... 18
17. Scutellum black, ninth tergum of male deeply excavated on posterior margin (fig. 163b), lobes of posterior lateral margins of sternum rounded (fig. 163a).
plagiata Wiedemann, p. 427
Scutellum bright orange, ninth tergum deeply excavated on anterior margin only gently concave on posterior margin (fig. 170a); posterior lateral margins of sternum square tipped (fig. 170b)*rufescutella* Hardy, p. 433
18. Head and body rather thickly black haired; ninth sternum very irregular on hind margin, with three pairs of lobes besides a median moundlike development, median pair of lobes finely toothed on inner margins (fig. 164e).....*nigra* (Philippi), p. 419
Species not so hairy, hypopygium different..... 19
19. Small species, length of wing 4.3-5.3 mm.; ninth tergum produced on posterior median and lateral margins (fig. 165a); entire notum minutely punctulated.
punctulata Hardy, p. 429
Larger species, not as above 20
20. Wings pale, yellowish to gray 21
Wings chiefly brown to black fumose..... 22
21. Mesonotum black, except around margins; pleurae and abdomen reddish.
marginata Edwards, p. 417

Entirely black, face scarcely produced below eyes, hind margin of ninth sternum with two pairs of well developed lobes (fig. 156a). Ninth tergum with a sharp triangular process in middle on hind margin (fig. 156b).....*nitidipes* Edwards, p. 421

- | | | |
|-----|---|--|
| 22. | Costal margin sharply contrasting with the rest of wing. | 23 |
| | Costal margin for the most part concolorous with rest of wing, or but slightly darker | 24 |
| 23. | Costal margin bright yellow | <i>costalis</i> Wiedemann, p. 404 |
| | Costal margin black | <i>imperialis</i> Schiner, p. 411 |
| 24. | Humeral ridges, scutellum and margins of ninth sternum strongly produced (fig. 146a) | <i>impulosa</i> Hardy, p. 412 |
| | Entirely black species, posterior lateral margins of sternum not produced (fig. 162a). | <i>maura</i> Walker, p. 417 |
| 25. | Entire thorax yellow to rufous; ninth tergum of male with a slitlike invagination in middle on hind margin (fig. 140c) | <i>ecuadorensis micans</i> Hardy, p. 407 |
| | Dorsum of thorax chiefly rufous, pleurae entirely black; tergum of male without narrow slitlike invagination | 26 |
| 26. | Anterior portion of notum with a conspicuous black or dark brown area. (collaris group) | 27 |
| | Entire dorsum rufous (bicolor group) | 30 |
| 27. | Ninth sternum with a pair of median processes on hind margin, with a small U-shaped cleft between; harpagones two lobed as seen from lateral view (fig. 133c), ninth tergum with a blunt process in middle (Brazil, Paraguay, Bolivia, Panama). | <i>collaris</i> Fabricius, p. 401 |
| | Without the above combination of characters | 28 |
| 28. | Ninth sternum with a large, blunt median development on hind margin, ninth tergum without median process | 29 |
| | Ninth sternum gently concave on posterior margin (fig. 134h), ninth tergum with a blunt median lobe (fig. 134c) | (Brazil) <i>brasiliensis</i> Hardy, p. 400 |
| 29. | Harpagones large and obtuse, ninth sternum extending greatly beyond bases of harpagones (fig. 149a). (Atypical specimens may run here) | (Brazil) <i>lundneri</i> Edwards, p. 414 |
| | Harpagones rather small, narrowly pointed; ninth sternum not greatly developed (fig. 178a) | (Honduras, Mexico) <i>uberta</i> Hardy, p. 441 |
| 30. | Posterior margin of ninth tergum developed into two long arms which extend inward toward the genital chamber (fig. 132c). Harpagones each with two strong sharp toothlike developments on inner side (fig. 132a) | (Mexico) <i>bicolor</i> Bellardi, p. 398 |
| | Not with the above characters | 31 |
| 31. | Harpagones simple, without secondary lobes | 32 |
| | Harpagones with two or three lobes | 37 |
| 32. | Aedeagus with a pair of accessory lobes which project outward from above the ninth sternum, very conspicuous from ventral view (fig. 159c) | (Cuba) <i>perpleza</i> Hardy, p. 423 |
| | Without such developments | 33 |
| 33. | Posterior median margin of ninth sternum strongly developed, harpagones slender but blunt (fig. 139a) | (Colombia) <i>disparis</i> Hardy, p. 406 |
| | Not as above | 34 |
| 34. | Ninth sternum with an acute median process (fig. 150b) | (Brazil) <i>lopesi</i> Hardy, p. 415 |
| | Without median process | 35 |
| 35. | Posterior median margin of ninth sternum with two pointed lobes, harpagones serrate on inner margins as seen from ventral view (fig. 175a) | <i>serrata</i> Hardy, p. 438 |
| | Not with these characters | 36 |
| 36. | Harpagones slender and sharply curved inward (from lateral view) (fig. 137b), posterior margin of ninth tergum gently concave (fig. 137d), small species. | (Mexico) <i>curvistylata</i> Hardy, p. 405 |
| | Harpagones broad and stout (fig. 180a), only a small concavity on posterior margin. | (Brazil) <i>vittata</i> Wiedemann, p. 442 |
| 37. | Harpagones with only two lobes | 38 |
| | Harpagones with three lobes as seen from a lateral view (fig. 177b). | (British Guiana) <i>trilobata</i> Hardy, p. 440 |
| 38. | Only one arm of the harpago visible from ventral view, ninth sternum not developed on posterior lateral margins (fig. 153) | (Mexico, North America) <i>nearctica</i> Hardy, p. 418 |
| | Both lobes visible from ventral view, posterior lateral margins produced (fig. 131a). | (Costa Rica) <i>biarmata</i> Hardy, p. 397 |
| 39. | Thorax entirely yellow to rufous | 40 |
| | Pleurae and anterior portion of notum black | <i>lundneri</i> Edwards, p. 474 |

40. Ninth tergum greatly developed into two large clasperlike lobes; tergum almost completely divided in middle (fig. 138c). Rostrum short.....*confusa* Loew, p. 402
Tergum not so developed; rostrum usually longer than the head..... 41
41. Ninth tergum with a distinct slitlike invagination in the middle on posterior margin, inner margins almost contiguous (fig. 140c)..... 42
Inner margins distinctly separated or without such an invagination..... 43
42. Posterior median margin of ninth sternum with a strong toothlike process; harpagones rather simple (fig. 140a).....*ecuadorensis* Hardy, p. 406
No such sharply pointed process in the middle of ninth sternum; harpagones greatly developed, very irregular in shape (fig. 181d).....*zenia* Hardy, p. 443
43. Posterior median margin of ninth sternum with one or more distinct processes or developments, at least with a moundlike gibbosity in middle..... 44
Without such developments 55
44. With two such processes, sometimes a somewhat membranous development between these 45
With only one median process or with a moundlike, sometimes membranous, swelling in middle 48
45. Two long armlike developments from middle of ninth sternum (fig. 157c); only a small V-shaped excavation on posterior margin of ninth tergum (fig. 157b).
panamaensis Hardy, p. 422
Median processes not so developed 46
46. Ninth tergum deeply cleft, more than half its length; median processes of sternum not divided apically, harpagones more narrowly pointed..... 47
Ninth tergum gently concave, cleft less than half its length (fig. 138b); median processes divided apically, harpagones more blunt apically.....*biformis* Hardy, p. 399
47. Cleft of tergum broad (fig. 147c); harpagones narrow, posterior lateral margins of sternum developed into clublike processes (fig. 147a).....*incurvata* Hardy, p. 413
Cleft narrow (fig. 151d); harpagones more broad, posterior lateral margins not so developed (fig. 151a)*maculata* Hardy, p. 416
48. Harpagones bilobed (fig. 128c); ninth tergum with a V-shaped indentation on hind margin, anterior margin of segment greatly excavated (fig. 128d).....*alacris* Curran, p. 395
Harpagones without a secondary lobe..... 49
49. Ninth tergum with only a small V-shaped cleft in middle on hind margin, or with but a slight indentation 50
Tergum moderately concave to angulate on hind margin..... 51
50. Ninth sternum deeply cleft, harpagones small (fig. 129d).....*americana* Hardy, p. 395
Sterna produced into an clavate process in middle, harpagones rather large and irregular (fig. 179a)*variabilis* Hardy, p. 441
51. Median process of ninth sternum blunt and rounding apically, somewhat membranous 52
Median process developed into two prominences apically, with a median depression, the process may be quadrate in outline 51a.....*rufithorax* Walker, p. 434
51a. Tergum gently concave on posterior margin (fig. 172d).
rufithorax concava Hardy, p. 435
Cleft of tergum with almost straight sides, scarcely rounded (fig. 171b).
rufithorax rufithorax Walker, p. 434
52. Tergum with a strong pointed process in middle on hind margin (fig. 161b), harpagones small (fig. 161a).....*pertinens* Hardy, p. 425
Tergum without such a development..... 53
53. Bottom of cleft on hind margin of tergum straight (fig. 167c).....*rectiora* Hardy, p. 431
Bottom concave or with small convexity in center..... 54
54. Tergum with a slight convexity in the middle of the broad concavity (fig. 143d); harpagones rather narrowly pointed (fig. 143e).....*gibbosa* Hardy, p. 409
Without such a median convexity (fig. 168d); harpagones not so sharply pointed (fig. 168c)*rostellata* Loew, p. 432
55. Ninth tergum moderately cleft 56
Never more than small V-shaped cleft on hind margin of tergum, or without cleft, 58
56. Tergum with a prominent median process on hind margin; harpagones small..... 57
Tergum without such a development, cleft broad and flat bottomed, *rectiora* Hardy, p. 431
57. Tergum with a more U-shaped concavity, median process well developed and stout (fig. 161b); bases of harpagones as wide as lobe of posterior lateral margin of ninth sternum (fig. 161a)*pertinens* Hardy, p. 425

- Hind margin of tergum more V-shaped, median process smaller, more spinelike (fig. 158b); harpagones very small (fig. 158a).....*parvistylata* Hardy, p. 423
58. Sternum cleft on hind margin..... 59
 Sternum broadly convex on hind margin, harpagones very irregular (atypical specimens may run here).....*zenia* Hardy, p. 443
59. Tergum with a small V-shaped indentation (fig. 129c); sternum cleft almost one-half its length (fig. 129d) (some atypical specimens of this species run out here).
americana Hardy, p. 395
 Tergum developed into a slight triangular point medianly (fig. 138d); ninth sternum with a small median cleft (fig. 138c).....*dentata* Hardy, p. 405

Plecia (Plecia) alacris Curran

(Plate XXX, figs. 128a-d)

Plecia alacris Curran, 1934, Bull. Amer. Mus. Nat. Hist. LXVI, 310, 311.

MALE.—*Head*: Rostrum shorter than the head and scarcely visible except from underneath. *Thorax*: Entirely yellow-orange on the mesonotum, pleurae slightly darker with a few indistinct brownish markings. Legs and abdomen black with black hair. *Wings*: Brownish yellow fumose, costal cell and stigma slightly darker, veins brown. Humeral crossvein and branch of radial sector (vein R_{3+4}) oblique, slanting straight into the costa (fig. 128a). The fork of the veins M_1 and $_2$ situated before basal one-third of the distance from the radio-medial crossvein to the fork of the radial sector and before the end of the subcosta. Vein R_{1+2} runs somewhat parallel with the costa through the stigmal area. Halteres with black knobs, stems pale. *Genitalia*: Ninth sternum very short in proportion to its width, almost twice as wide as long, slightly longer on the lateral margins; posterior median margin of segment with a large blunt development (fig. 128b). Harpagones appearing simple from ventral view, only one rather acutely pointed lobe visible. From a lateral view a second, lower lobe is visible; this lobe is strong, tooth-like and projects inward (fig. 128c). Ninth tergum with a small V-shaped excavation on the hind margin and another deeper concavity on the anterior margin, the two median points almost dividing the segment into two parts (fig. 128d).

Length: body, 6-6.5 mm.; wing, 6.5 mm.

Female unknown.

Described from British Guiana, type in American Museum.

The writer has examined a paratype male, also one male from Paraguay.

Plecia (Plecia) americana Hardy

(Plate XXX, figs. 129a-d)

Plecia americana Hardy, 1940, Journ. Kan. Ent. Soc. 13: 15-16.

This species is related to *confusa* Loew but is of smaller size, the antennal segments are more compacted and the development of the

ninth sternum and tergum will distinguish it. Following is the original description of the male hypopygium:

"Male genitalia: Ninth sternum deeply concave on posterior margin, cleft about one-half the length of the segment, with a membranous mound in the middle; posterior lateral margins moderately produced; harpagones very small (fig. 129d). Ninth tergum broad, with a small V-shaped excision in the middle on the hind margin (fig. 129c)."

Male length: body, 4.5-5.3 mm.; wings, 5-6 mm.

Female genitalia: The eighth sternum is developed into a pair of strong, heavily sclerotized lobes joined by a comparatively narrow bridge medianly at the anterior portion of the segment (fig. 129a). Ninth tergum narrow, about one-fourth as long as wide, on lateral margins; posterior margin almost straight, very slightly concave. Cerci large and round, densely covered with strong bristles and hairs (fig. 129b). Lateral margins of ninth tergum greatly developed and curved inward giving support to the walls of the genital chamber.

Length: body, 5-6 mm.; wings, 7 mm.

Type locality: Florida.

Type in the United States National Museum collection.

This species is known also from Georgia, Mexico, North Carolina, South Carolina. Texas and Alabama.

Plecia (Rhinoplecia) avicephaliforma Hardy

(Plate XXX, figs 130a-d)

Plecia avicephaliforma Hardy, 1940, Journ Kan Ent. Soc 13, 16.

Following is the original description:

"This species is related to *quadrivittata* Williston in having four shining stripes down the mesonotum, the median stripe being divided by a narrow gray line. It differs from this species in having the rostrum shorter than the head; the scutellum opaque (shining in *quadrivittata*); vein R_{2+3} (R_{3+4}) curved or bowed before entering the costa. The male genitalia is very distinctive, as is pointed out in the description; the specimens are also slightly smaller.

"Male.—Entire black species. *Head:* Antennae nine segmented, the segments short and compressed; rostrum about equal to the antennae in length, shorter than the head. *Thorax:* Opaque, lightly pruinose, except for shining stripes on dorsum; upper portions of sternopleurae with sparse brownish hairs, mesonotal furrows and margins of notum with scattered yellowish hairs. Legs and abdo-

men with brown to black pile. *Wings*: Brownish fumose, veins dark brown, stigma but slightly darker than membrane; vein R_1 ends at about two thirds the distance from end of subcosta and R_{2+3} (R_{3+4}), vein R_{2+3} (R_{3+4}) strongly curved into the costa (fig. 130a). Radial crossvein situated at about the middle of the distance from the m-cu crossvein and the fork of media.

"Male genitalia: Sternum rather broad, developed apically into two pairs of small lobes, the lateral pair larger more rounding, the median pair small, sometimes scarcely divided and simulating a single development (fig. 130b). Harpagones simple, with a long beaklike tooth projecting inwardly (avicephaliform) as seen from a lateral view (fig. 130c); scarcely visible from ventral view. Tergum gently concave with a broad flat topped development medianly (fig. 130d).

"Length: body, 3.3-3.7 mm.; wings, 4 mm.

"Female unknown."

Type locality: Diamantina, Minas Geraes, Brazil.

Type in Cornell University Collection.

Plecia (Rhinoplecia) biarmata Hardy

(Plate XXX, figs 131a-b)

Plecia (Rhinoplecia) biarmata Hardy, 1942, Can Ento LXXIV, 105-106

"This species is related to *bicolor* Bellardi and cannot be separated from that species without use of the male genitalia. The fork of the Rs arises at the end of vein R_{1+2} ; R_{3+4} arises vertically for a short distance than slants gradually into the costa in the male, more obliquely in female. These characters may be variable and would not present a convenient means of separation.

"Male Genitalia: The genitalia of this species are extremely diversified, the ninth sternum is very broad, with a medial projection which is concave on its posterior margin. The claspers are large and divided into two well developed lobes visible from above; the outer arms being more stoutly developed (fig. 131b). The ninth tergum is gently concave on its posterior margin (fig. 131a).

"In the female the metapleurae, hypopleurae, ptero and propleurae are rufescent tinged; the antennae are eleven segmented, with the segments rather compressed.

"Length: male, body, 4.5 mm.; wings, 4.7-5 mm.

"Female, body 5 mm.; wings, 6-6.5 mm."

Type locality: Crontena, Costa Rica.

Type in Cornell University collection.

Plecia (Rhinoplecia) bicolor Bellardi

(Plate XXX, figs. 132a-e)

Plecia bicolor Bellardi, 1859, Saggio di Ditterologia Messicana, pt. 1, 16.

MALE.—*Head*: Rostrum developed to form a beak, longer than the head and extending backward beneath the face. Antennae nine segmented, brown to black with a slight yellowish tinge at the base of the segments; segment three equal to the first two in length, other segments more nearly equal. Ocellar tubercle very prominent, as is the case in most species of this genus. Compound eyes divided into upper and lower portions by a slight indentation of the lower third or fourth. *Thorax*: Dorsum bright orange, with three longitudinal grooves which converge slightly before the scutellum. Pleurae velvety brown to black. Halteres brownish black. *Legs*: Slender, brownish black with dense, short black hair. All femora and posterior tibiae straight or nearly so. Basitarsi about equal in length to the next three tarsal subsegments, pulvilli yellow. *Wings*: Brownish yellow fumose, costal cell brown, stigma not noticeably differentiated. Fork of third vein arising before the end of second vein, slanting rather sharply toward the costa. Fork of the fourth vein but little before the middle of the base of vein M_{3+4} and fork of the third vein. Cubital cell widely open. *Abdomen*: Subopaque brownish black with dense dark hairs. *Genitalia*: Ninth sternum narrowing posteriorly with a rounding concavity on the posterior margin (fig. 132b). Claspers very broad and irregularly toothed on the inner margin, two large sharp pointed teeth above and several below as seen from a lateral view (fig. 132a). The claspers are folded down in their normal position so they are somewhat difficult to see from a ventral view. Ninth tergum developed on its hind margin into two long armlike projections, these fold toward the genital chamber in their normal position so the tergum must be tilted up slightly to see them (fig. 132c).

Length: body, 4 mm.; wing, 4.5 mm.

FEMALE.—Other than in the secondary sexual characters and slightly larger size the female does not differ a great deal from the male. *Genitalia*: Eighth sternum produced into two pairs of strong posterior lobes, the outer lobes are rounded apically, the inner pair are elongated, slender and greatly curved outwardly; these processes arise from the upper portion of the sternum. The eighth sternum is deeply cleft medianly with only a narrow strip of sclerite joining the two plates at their bases. This cleft broadens posteriorly and the margins are straight (fig. 132e). Ninth tergum deeply U-shaped

on hind margin, this cleft extends three fourths the length of the tergum. The cerci are elongated and slender (fig. 132d).

Length: body, 5 mm.; wing, 6.3 mm.

Type located at University of Turin.

Specimens examined from the type locality of the species, Cordova (Cordoba) and Orizaba, Mexico (Frederick Knab), also Teapa, Tabasco, Mex., Jan., 1903, and Barro Colorado Isld., Canal Zone, Feb. 18, 1929 (C. H. Curran).

Plecia (Rhinoplectia) biformis Hardy

(Plate XXXI, figs 133a-d)

Plecia (Rhinoplectia) biformis Hardy, 1942, Can. Ento. LXXIV, 106.

"This species is related to *rufithorax* Walker by having the thorax entirely rufous and the rostrum produced longer than the length of the antennae. The genitalia also show relationship but the specific characters are very pronounced in both sexes.

"*Male genitalia*: The posterior lateral margins of the ninth sternum are not produced and the hind median margin is developed into two prominent lobes, each is divided at its apex, a V-shaped cleft separates the two developments (fig. 133a); the sternum is slightly grooved longitudinally down the middle. The harpagones are strongly produced on upper apical edges and each is developed into a sharp pointed tooth below. The upper lobe is much larger, more obtuse while the lower is smaller more acute, instead of the lower portion of the apex being the more strongly developed as in *rufithorax*. The ninth tergum is much shorter than the sternum and rather deeply concave on posterior margin, posterior lateral margins rather acutely pointed, not so rounding as in *rufithorax*. The bottom of the cleft has a slight membranous portion and the margins are covered with dense short hair (fig. 133b).

"Length: body, 4.5-5 mm.; wing, 5.5 mm.

"*Female genitalia*: The eighth sternum is developed into a pair of median lobes on hind margin, with a deeply V-shaped cleft between; this cleft extends nearly half the length of the segment. Posterior lateral margins broadly rounding, covered with dense fine hairs on the sides; the sternum is almost twice as wide as long (fig 133c) and differs from *rufithorax* in the development of the posterior margin. The ninth tergum has a broad troughlike cleft extending half the length of the segment, the lateral lobes are rather square-topped (more undulated in *rufithorax*) and are densely covered with fine hair. Cerci broad and rounding (fig. 133d).

"Length: body, 7 mm.; wing, 7.5-8 mm."

Type locality: Trinidad.

Type in the Snow Entomological Collection.

Plecia (Rhinoplecia) brasilana Hardy

(Plate XXXI, figs. 134a-c)

Plecia (Rhinoplecia) brasilana Hardy, 1942, Can. Ento. LXXIV, 106-107.

"This species is related to *collaris* Fab. by having the anterior portion of the dorsum blackish. It is distinguished from other species in this complex by having the posterior margin of the ninth sternum concave and by the blunt median lobe of the ninth tergum.

"**MALE.**—*Head:* Rostrum greatly produced, almost twice as long as head and about three times as long as the antennae. Antennae yellow-brown to dark brownish, composed of nine segments. Compound eyes divided by a transverse groove at about lower one-third. *Thorax:* Dorsum rufous with a dark brown to black discoloration on the anterior portion in the middle, pleurae reddish brown to black, much darker in color than the dorsum. Sternopleurae shining on the lower halves, pleurae otherwise subopaque. Stems of halteres reddish to slightly brownish, knobs brown. *Legs:* Bases of femora yellowish, verging into rufescent brown apically, legs otherwise brown to black; pile short, dense and black. Basitarsi about equal to the next three subsegments in length. *Wings:* Brownish fumose, anterior branch of radial sector (R_{3+4}) arising slightly beyond the end of R_{1+2} and extending almost vertically into the costa. Fork of media arising at about one third the distance between the r-m crossvein and the fork of the Rs. Cubital cell widely opened (fig. 134a). *Abdomen:* Faintly shining on the venter, opaque above. *Genitalia:* Ninth sternum rather broad with a moderate concavity on the posterior border in the middle, developed into a heavily sclerotized point on each posterior lateral margin. Claspers simple, bluntly pointed and slightly curved outward (fig. 134b). Ninth tergum somewhat divided into two portions by a V-shaped groove in the middle on the posterior margin, out of which arises a blunt, almost square-topped development (fig. 134c).

Length: body, 3.8-4 mm.; wing, 4.6-4.8 mm.

"**FEMALE.**—Differs in having the rostrum even more elongate, the femora are more yellow basically, R_{3+4} arises vertically for a very short distance, then slants obliquely into the costa. Antennae eleven-segmented.

"Length: body, 4.3 mm.; wings, 5.4 mm."

Type locality: West Border, Matto Grosso, Brazil.

Type in United States National Museum.

Plecia (Rhinoplectia) collaris (Fabricius)

(Plate XXXI, figs. 135a-e)

Hirtea collaris Fabricius, 1805, Syst. Ant. 54.

The type of this species has apparently been lost and the species is unidentifiable from the original description. The common South and Central American species of the *collaris* group is no doubt what Fabricius had before him; this is described here.

The complexity of the male harpagones and development of the ninth sternum makes this species easy to recognize. The black spot on the dorsum of the thorax is also more extensive than in other members of the group.

MALE.—*Head*: Rostrum developed longer than the antennae and folded beneath the face. Antennae eight segmented, scape yellow, other segments black. *Thorax*: Mesonotum bright orange with a large dark brown to black spot covering the anterior one-third of the dorsum. Humeral ridges yellowish. Pleurae brownish, tinged with rufous. Stems of halteres reddish, knobs brown. Legs and abdomen brown to black. *Wings*: Yellowish fumose, slightly brown costally, veins and stigma brown. Vein R_{3+4} (fork of third vein) arising beyond end of R_{1+2} , the lower one-half of the vein vertical, the apical portion slanting rather abruptly into the costa. Fork of M_1 and $_2$ at about one-third the distance from basal portion of M_{3+4} to the fork of the Rs. *Genitalia*: Ninth sternum slightly wider at bottom, gradually slanting toward the apex, terminating in a bilobed projection. Harpagones very broad and irregular; seen from above as a stout dorsal development, and a basal, slightly pointed process (fig. 135e). From a lateral view the claspers appear to be bilobed (fig. 135c), the upper lobe more broad and beaklike, the lower produced laterally, pointing dorsally in its normal position. Ninth tergum gently concave with a projection in the center, this in turn having a small concavity (somewhat V-shaped) on its posterior edge (fig. 135d).

Length: body, 5.5-6.5 mm.; wings, 6-6.5 mm.

FEMALE.—Antennae ten segmented, rostrum slightly longer, otherwise like the male except for sexual differences. *Genitalia*: The ninth tergum is broadly U-shaped on posterior margin, posterior lateral margins rounding (fig. 135a). Cerci thickly haired and elongated in shape. The eighth sternum is abnormally developed,

not completely divided medianly, with a narrow sclerite joining the two plates near the base of segment. The sternum is produced into a pair of strong, obtuse lobes near median portion on hind margin and another pair of acutely pointed lobes just below these on their inner margins, another strong process extends in toward the genital chamber, this structure is attached to the upper portion of the eighth sternum on top side (fig. 135b).

Length: body, 5-7.5 mm.; wing, 7-8 mm.

Type locality given as "America meridionali."

Present location of type unknown by this writer.

The writer has identified the species from the following localities:

Argentina: Posados, Misiones Terr. 13-15, i, 1927-63 (F. and M. Edwards); B. Aires—Tigre, I, 1938 (F. Schade).

Bolivia: Rosario Lake, Rogague, Oct. 28-Nov. 9, 1921 (W. M. Mann, Mulford Biol. Expl.).

Brazil: Sao Paulo, Oct. 16, 1934 (L. T. F.); Santa Maria, State of Rio Grande do sul (T. White); Corumba, Matto Grosso, Dec. 14-23, 1919 (R. G. Marris); Brasilien Nova Teutonia, 27° 11' B. 52° 23' (F. Plaumann).

Colombia: Bet. Queremal and Buenaventura, alt. 3,500-4,000 ft., Feb. 12, 1935 (H. F. Schwarz); Cali District, Cauca Valley, alt. 3,260 ft., Feb. 20, 1935 (H. F. Schwarz); Popayan, alt. 6,800 ft., Feb. 15, 1935 (E. I. Huntington and H. F. Schwarz); Medellin (H. Daniel).

Honduras: Subirana Yoro, Dec. 21, 1932 (Stadelmann).

Panama: Patilla Pt. Can. Zone, Jan. 15, 1939 (C. H. Curran); Porto Bello, Feb. 15, 1911 (E. A. Schwarz).

Paraguay: Accession numbers 5 and 182 (Zurcher leg.) Tacuru-Pucu, 2-7 Apr. (D. Wees); Villarica, X, 1936 (F. Schade).

Plecia (Plecia) confusa Loew

(Plate XXXI, figs. 136a-d)

Plecia confusa Loew, 1858, Berl. Ent. Zeit. 11, 109.

This is a change of name for *P. ruficollis* Fabricius, 1805, Systema Antiliatorum, p. 53 (Middle America); as distinguished from *Plecia ruficollis* Fabricius, 1781, Species Insectorum Vol. 2, 410 (Cape of Good Hope).

Loew's type of *confusa* has apparently been lost, as it was not to be located in the European Museums, so it has been necessary to erect Wiedemann's specimen from Bahia, Brazil, as a neotype. Wiedemann determined this species as *ruficollis* Fabr. and Loew

later changed the name. This species has been studied by the late Doctor Edwards and drawings of the male genitalia sent to the writer. This proved to be identical with a Brazilian *Plecia* already at hand. This species is larger in size than any other in this complex, known to the writer, and it is unique in the development of the male genitalia.

MALE.—*Head*: Rostrum short, less than one-half the length of head. Palpi four segmented, the segments long and slender. Antennae ten segmented, counting the distinct apical tip; the first segment of flagellum about twice as long as wide, other segments rounding, slightly oblong. *Thorax*: Entirely deep yellow to orange. Mesonotum with two longitudinal furrows which converge slightly before the scutellum; lateral mesonotal slopes flat, and a slightly concave area present just behind the humeral ridges. Sternopleurae with a sparse patch of short brown to black hairs just above middles, thorax otherwise chiefly bare. Knobs of halteres brown, stems pale. Legs and abdomen dark brown to black with dense black hair. Femora thickened apically, tibiae straight or nearly so; basitarsi equal to scarcely longer than succeeding three tarsal subsegments. *Wings*: Yellow-brown fumose, costal cell and stigma more browned; vein R_{1+2} ending but slightly before the end of R_{3+4} ; anterior branch of radial sector (vein R_{3+4}) oblique with a slight curve toward its base (fig. 136d). Fork of M_1 and 2 at basal one-third of the distance between the r-m crossvein and the fork of the Rs. *Genitalia*: Ninth sternum much wider than long; posterior lateral margins developed into strong, hairy clasperlike lobes; hind margin slightly undulated in the middle, otherwise almost straight (fig. 136a). Two unmounted specimens show minute teethlike bumps on the inner edges of the lobes, these are not visible on genitalia mounted on a slide and are probably obscured by the flattening out of the structure. Cerci slender, spinose and much longer on inner margin.

Length: body, 7.5-9 mm.; wing, 8.5-9.5 mm.

FEMALE.—The antennae are slightly longer and eleven segmented, including nipplelike tip which is not so pronounced as in the male; palpi yellow-brown, about as long as the antennae. Otherwise like the male, except for shorter body and longer wings.

Length: body, 6-7 mm.; wing, 11-12 mm.

Neotype locality: Bahia, Brazil.

Neotype at Vienna.

Specimens have been examined from Rio Colorado, Bolivia, Sept.

1921-22 (Mulford Bio.-Expl.); Boa Vista Tapajos, Para. (Townsend); Barro Colo. Isld., Canal Zone, II, 13, 1929 (C. H. Curran); Bet. Queremal and Buenaventura, Colombia, alt. 35-4000 ft., XII-11-1935 (A. E. Schwarz); Chanchamayo E. Peru (Rosenberg); Piches and Perene Vs Peru, 2,000-3,000 ft. (Lima); LaChorrera Puta, Mayo Distr. Peru, 17-20, Aug., 1920 (Cornell Univ. Exped. Lot 569) and Igrapinna, Bahia, Brazil, 23-29 June, 1919.

Plecia (Plecia) costalis Wiedemann

Plecia costalis Wiedemann, 1880, *Ausereuropasche Zweiflug Ins* 2, 618 (nec *costalis* Walker)

MALE.—Redescription of type. Black; rostrum short, much shorter than antennae; antennae nine segmented. Body entirely opaque. Thorax with very sparse, pale pile; upper portions of sternopleurae with long dark hairs. Male genitalia undissected, but the ninth tergum is deeply V-shaped cleft. The harpagones appear to be small and inconspicuous. Wings brown fumose, veins darker brown; costal margin, humeral crossvein, subcosta, base of wing and bases of R and R_{1+2} oblique. Fork of media situated before middle of distance from r-m crossvein to fork of radial sector. Halteres brown.

FEMALE.—Entirely opaque black. *Head*: Rostrum not greatly produced, slightly over one-half the length of the antennae; antennae eleven segmented, shorter in length than the palpi; compound eyes covered with short hair. *Thorax*: Dorsum with sparse, recumbent, brownish pile; sternopleurae each with a dense patch of black hairs above; stems of halteres yellow-brown, knobs brown. Legs and abdomen densely black pilose. *Wings*: Largely brown to blackish fumose with the costal margin and base of wing bright yellow (this is a striking characteristic of the species). Vein R_{3+4} oblique, with a very slight curve near its base; vein M_{3+4} situated at about the basal third of the distance from the r-m crossvein to the fork of the R_s .

Length male: 9.8-10.5 mm.; wing, 11-12 mm.

Female: body, 11-12 mm.; wing, 14.5-15.4 mm.

Described from Brazil. The writer has seen specimens from Petropolis, Rio de Janeiro. It has also been reported from Parana. Three specimens from the type series have been examined, one male and two females. Kindly loaned by Zoölogisches Museum der Universität Berlin.

Plecia (Plecia) curvistylata Hardy

(Plate XXXI, figs. 137a-d)

Plecia (Plecia) curvistylata Hardy, 1942, Can. Ento. LXXIV, 107.

"This species is probably closer to the *collaris* group as the anterior portion of the mesonotum is discolored. This discolored area is, however, only slightly darkened and not distinctly blackened as in others of the complex. This species is also of much smaller size, the rostrum is not quite as long as the antennae and R_{3+4} is more decidedly curved before entering the costa (fig. 137a). The male genitalia will distinguish it.

"*Male genitalia*: Posterior lateral margins of the ninth sternum not developed, hind margin with a gentle concavity in the middle. Harpagones elongate and curved inward (fig. 137b), only their bases visible from ventral view (fig. 137c). Ninth tergum deeply concave on hind margin, wider than long (fig. 137d).

"Length: body, 3-3.5 mm.; wing, 3.6-4 mm."

Type locality: Cuernavaca, Morelos, Mexico.

Type to be returned to the British Museum.

Plecia (Rhinoplecia) dentata Hardy

(Plate XXXI, figs. 138a-d)

Plecia (Rhinoplecia) dentata Hardy, 1942, Can. Ento. LXXIV, 107

"This species approaches *rufithorax* Walker and can be separated conveniently only by use of the male genitalia, these structures differ very distinctly. The wing venation also differs as follows: The fork of the radial sector (R_{3+4}) arises vertically toward the costa then makes a sharp turn into the wing margin (fig. 138a); fork of media situated slightly before middle of the distance between r-m crossvein and fork of Rs; Cu strongly curved downward, narrowing the cubital cell.

"*Genitalia*: Posterior margin of ninth sternum with a U-shaped concavity. Posterior lateral margins rather strongly developed. Harpagones large, blunt with a small beaklike apex as seen from ventral view (fig. 138c); from a lateral view a toothlike development is visible on the dorsal surface (fig. 138b). Apices of harpagones covered with dense short, brownish pile and long hairs. The exact shape of the clasping structures is difficult to discern and many interpretations may be had according to the angle from which they are viewed. If tilted downward the inner margin of the apex will appear much more blunt and rounding than shown in the figure.

Ninth tergum but little wider than long, with a small convexity on the posterior margin (fig. 138d).

"Length: body, 5-6 mm.; wings, 6.5 mm."

Type locality: Chontales, Nicaragua (Janson).

Type will be returned to British Museum.

Plecia discolor Van der Wulp

Plecia discolor Van der Wulp, 1881, Amer. Dip. I, Tijdschr. Ent. XXIV, 143.

The description of this species is too inadequate to place it properly, it belongs in either the *bicolor* or *collaris* group and may prove to be the same as *collaris* (Fabricius) but until the type can be located and studied its true position will remain questionable.

Type locality: Argentina.

Type probably at Amsterdam or Leiden.

Plecia (Rhinoplectia) disparis Hardy

(Plate XXXI, figs. 139a-b)

Plecia (Rhinoplectia) disparis Hardy, 1942, Can. Ento. LXXIV, 108.

"Related to *Plecia bicolor* Bell, but differing distinctly in the male genital structures; the wings also appear to be more lightly fumose.

"*Male genitalia*: Ninth sternum broad with a well developed median process on its posterior border (fig. 139a), apodeme of ninth sternum greatly developed and rounding at the apex, sometimes appearing to be a second lobe of the harpagones from a lateral view; harpagones broad, bluntly tipped. Aedeagus large and rounding with two heavily sclerotized supporting processes laterally. Ninth tergum moderately concave, the bottom of the concavity almost straight (fig. 139b).

"In other characters this species cannot be separated from *bicolor* Bell.

"Length: body, 5.3 mm.; wing, 6 mm."

Type locality: Upper Putamyo River, Colombia.

Type in the United States National Museum.

Plecia (Rhinoplectia) ecuadorensis Hardy

(Plate XXXII, figs. 140a-c)

Plecia (Rhinoplectia) ecuadorensis Hardy, 1942, Can. Ento. LXXIV, 108.

"This species is related to *rufithorax* Walker and can only be separated by the marked structural differences in the male genitalia. The specimens are of slightly larger size and vein R_{3+4} is curved rather sharply near the base (as is fig. 138a).

"Male genitalia: Approaches *xenia* Hardy in having the posterior lateral margins of ninth sternum strongly developed and the ninth tergum with a narrow slitlike invagination extending over one-third the length of the segment down the middle. Ninth sternum gradually convex on the hind margin with a strong acutely pointed development medianly (fig. 140). Harpagones large and somewhat irregular but without such processes as possessed by *xenia*, developed into a rather acute point apically above, as seen from a ventral view and with a sharp toothlike point above from a lateral view (fig. 140b). Ninth tergum longest on the lateral margins, gently concave on the posterior margin; segment wider than long (fig. 140c). The genitalia differs from *xenia* in the development of the tergum, sternum and harpagones.

"The female genitalia have not been dissected.

"Male length: body, 6-6.5 mm.; wing, 7-8 mm.

"Female length: body, 7-7.5 mm.; wing, 8-8.5 mm."

Type locality: Ecuador, S. America.

Type to be returned to the British Museum. At present in the Snow Entomological Collection.

The species has also been recorded from Pasto, Colombia.

Plecia ecuadorensis micans Hardy

(Plate XXXII, figs. 141a-b)

Plecia ecuadorensis var. *micans* Hardy, 1942, Can. Ento. LXXIV, 108-109.

"This variety differs from the type species in having the mesonotum and lower portions of the sternopleurae shining reddish instead of opaque yellow-orange; the variety is also smaller in size. The females are sometimes marked with black on the dorsum, one specimen has the entire thorax deeply black tinged.

"Female genitalia: Ninth tergum with a broad, flat bottomed cleft on hind margin; posterior lateral margins rounded. Cerci rounded apically, longer than wide (fig. 141b). Eighth sternum distinctly divided into two plates by a deep cleft extending down the middle longitudinally, posterior margins of each plate produced into a large rounding median lobe and a moundlike swelling toward the sides; segment about twice as wide as long (fig. 141a).

"Male length: body 3.5-4 mm.; wing, 5-5.5 mm.

"Female length: body, 5 mm.; wing, 6.5 mm.

"These would certainly appear to belong to a different species but the male genitalia are identical. This is the only example the writer has encountered in the *rufithorax* group in which the thorax is not opaque."

Type locality: Guayaquil, Ecua.

Type in the United States National Museum Collection.

This variety has also been recorded from Hulgra, Ecuador.

Plecia (Rhinoplectia) edwardsi Hardy

(Plate XXXII, figs. 142a-b)

Plecia edwardsi Hardy, 1940, Journ. Kan. Ent. Soc. 13, 17.

Following is the original description:

"This is a sexually dimorphic species related to *Plecia seminitens* Edwards, the males differing in having the mesonotum almost entirely shining, not divided into stripes by gray vittae, only a small slightly grayed spot behind the humeral ridges and a narrow line of gray along lateral margins of mesonotum. The median groove of the notum is as deep as the lateral ones; the posterior tarsal segments are noticeably swollen and rounding. The genitalia are also very different, *edwardsi* does not have the posterior margin of the ninth tergum nearly straight and the harpagones bilobed as does *seminitens* Edwards. The females differ in having the thorax entirely rufous. Vein R_{2+3} (R_{3+4}) is markedly curved in the males and more oblique in the females.

"*Male genitalia*: Ninth sternum slightly convex on median posterior margin with a moundlike membranous gibbosity in the middle, posterior lateral margins not greatly developed, irregular, with two to three small rounded developments. Harpagones simple and vertical in position, not lateral as in *seminitens*, terminating in a small point apically and a blunt rounded projection on inner side (fig. 142a). Ninth tergum deeply U-shaped concave (fig. 142b).

"Male length: body, 2.5-3 mm.; wing, 3-3.2 mm.

"Female length: body, 2.7-3 mm.; wing, 3.5-3.7 mm.

"Type locality: Jussara, Angro Dos Reis, Brazil."

Type in the Snow Entomological Collection.

Plecia fulvimacula Walker

Plecia fulvimacula Walker, 1848, List of Dipt. Brit. Mus. I, 116.

Plecia flavimaculata Hunter, 1900, Trans. Amer. Ent. Soc. XXVI, 297. (This is an erroneous spelling for *fulvimacula*).

From the description this appears to belong to the *collaris* group. The writer is unable to place it, so is quoting the original description.

"Nigra, thoracis lateribus fulvo maculatis, metathorace rufofusco, abdomine picco, antennis nigris, femoribus basi piceis, alis nigrofusis.

"Body black, shining: feelers black; chest with a large tawny spot

on each side above the base of the wing; hind chest reddish brown; abdomen dull piceous; legs black, shining; thighs piceous towards the base; wings dark brown, specially towards the fore border, where there is a small narrow black band; veins and poisers piceous. Length of the body 4 lines; of the wings 8 lines."

Type locality: Venezuela.

Type in British Museum.

Type in the United States National Museum.

Doctor John Smart has recently informed the writer that the *fulvimacula* type appears in the British Museum collection under the genus *Dilophus*; if this is correctly placed it seems strange that Walker should have described it as a *Plecia*.

Plecia (Rhinoplecia) gibbosa Hardy

(Plate XXXII, figs. 143a-e)

Plecia (Rhinoplecia) gibbosa Hardy, 1942, Can. Ento. LXXIV, 109.

"This species is closely related to *rostellata* Loew because of the structural similarities. The rostrum is not so long as in that species, being about as long as the head, slightly shorter than the antennae and the genitalia of both sexes differ considerably. The harpagones are more sharply pointed, the median lobe of the sternum is membranous and rather square-topped; the hind margin is produced into a pair of rounded lobes at the base of the claspers and the posterior lateral lobes are more strongly developed, extending over one half the length of the claspers. From end view the hind margin of the tergum is seen to fold back, producing a broad shelflike portion extending around the upper part of the genital chamber; the median portion is developed into a strong point (fig. 143c). The mesonotum of the male has sparse, short black hairs on the sides; propleurae and anterior part of mesopleurae and sternopleurae with somewhat obscure brown markings. Abdomen more sparsely haired, with fine, light brown pile; also of smaller size. In addition to the above the posterior lateral margins of ninth sternum are developed, hind margins with a median gibbosity of a somewhat membranous nature. Harpagones simple, with beaklike apices (fig. 143e). Ninth tergum concave on the posterior margin, with a small convexity in the bottom of the cleft (fig. 143d).

"*Female genitalia*: Eighth sternum completely divided into two plates by the median cleft. Median lobes of hind margin rounded; lateral lobes square topped, extending less than one-half the height of the median pair; segment much wider than long (fig. 143b). The

lateral lobes of *rostellata* are acutely pointed and the entire segment is differently shaped. Ninth tergum about four times as wide as longest point, with a very broad, deep cleft on hind margin and a distinct convexity in the bottom of the cleft (fig. 143a). This sclerite differs strikingly from *rostellata* in that the anterior lateral margins are not at all produced and the bottom of the cleft not square.

"Male length: body, 5.5-6 mm.; wings, 6.5 mm.

"Female length: body, 7 mm.; wings, 8 mm."

Type locality: S. Bernardino, Paraguay.

Type in the United States National Museum.

The species has also been recorded from San Jose, N. Arg.

Plecia (Rhinoplecia) grisea Edwards

(Plate XXXII, figs. 144a-b)

Plecia (Rhinoplecia) grisea Edwards, 1938, Ann. Mag. Nat. Hist. Ser. 11, No. 10, 322-323.

The following are diagnostic points taken from the original description with a few additions by the writer: Black, without markings; only the stems of halteres pale; antennae eight segmented; rostrum about as long as antennae; thorax almost uniformly dusted, even on scutal stripes, appearing gray when viewed from the front; sternopleurae with a few short pale hairs; wings smoky. Female coloring as in male, head gray dusted, vein R_{3+4} (R_4 of Edwards) more oblique than in male. Antennae eleven segmented. The male specimen examined has a faint reddish tinge on margins of mesonotum, scutellum, postnotum, metapleurae and hypopleurae. The abdomen is also yellow haired.

Male genitalia: Ninth sternum with a blunt, median development on hind margin, posterior lateral margins produced. Harpagones rather large and terminating in a blunt point (fig. 144a). Ninth tergum gently concave, with a small bumplike swelling in the middle (fig. 144b). Doctor Edwards has stated that the tergum has a broad V-shaped excavation and a small bilobed process at bottom of V. The tergum of the specimen examined hardly fits this. The writer is unable to find any bilobed condition in the median process, from a dorsal view. By tipping the segment forward this bump appears to be slightly notched in the middle and the process spoken of may fold backwards so it would not be visible in some specimens.

Wing length: male, 7 mm.; female, 9 mm.

Doctor Edwards has suggested that this might be a variety of *maura* Walker, but this writer would consider them very distinct.

species, the ninth tergum and the sternum as well as the characters given by Edwards separate them.

Type locality: Nova Teutonia, Brazil.

Type in British Museum.

Specimen examined from the type locality, presented by Doctor Edwards.

Plecia (Plecia) imperialis Schiner

(Pilate XXXII, figs. 145a-b)

Ple. imperialis Schiner, 1867, Diptera, Reise der Oesterreichischen Fregatte um die Erde. 22.

This species is readily recognized by the blackish costal margin of the wings and the distinctive genital characters.

MALE. — Large, opaque black, chiefly bare species. Compound eyes not divided by a transverse depression; face densely black haired. Rostrum not greatly produced, little over half the length of antennae. *Thorax*: Very faintly grayed, sternopleurae bare or with but a few short hairs. Mesonotum with but a few scattered hairs and with two rather faint longitudinal furrows which converge slightly before the scutellum. *Wings*: Largely yellowish, the costal margin broadly blackish from base to apex; stigma concolorous with the membrane of the costal margin. Vein R_{3+4} short, almost vertical, very slightly curved. *Genitalia*: Ninth sternum about as long as wide, posterior lateral margins produced into a pair of elongated hairy lobes; posterior median margin square topped with a concavity at the base of each clasper. Harpagones rather small, shining black and slender, folded inward toward genital chamber in normal position (fig. 145a). The ninth tergum is almost completely divided into two lobes by deep clefts on its posterior and anterior margins, only a very narrow bridge of sclerite joins the two lateral lobes; the posterior margin of tergum is armed with strong bristles (fig. 145b).

Length: body and wings, 9.3-10 mm.

Schiner states that the female is comparable to the male but is of larger size and other than sexual characters the yellow coloring of the wings is more extensive.

Type locality: Colombia.

Type in Vienna Natural History Museum.

The writer has a male specimen from Fusagasuga, Colombia (Apolinar Maria).

Plecia (Rhinoplecia) impilosa Hardy

(Plate XXXIII, figs. 146a-b)

Plecia impilosa Hardy, 1940, Journ. Kan. Ent. Soc. 13, 17-18.

Following is the original description:

"This species is related somewhat to *grisea* Edwards and *maura* Walker, it differs in coloration and is not so consistantly grayed as *grisea*; the wings are more yellowish and the genital characters are distinctive.

"**MALE.**—Chiefly black species. *Head*: Rostrum developea, longer than the antennae, antennae eight segmented; compound eyes not noticeably divided into two portions. *Thorax*: Chiefly bare, with only microscopic hairs on upper portions of sternopleurae and on dorsum. Humeral ridges brick-red; margins of mesonotum, scutellum, metanotum, pteropleurae, metapleurae and hypopleurae with an ochraceous to reddish tinge, this sometimes extends along the mesonotal furrows. Mesonotum chiefly gray dusted, this pruinosity is more distinct on the front sides and in the middle of the furrows; mesopleurae and sternopleurae grayed, the latter subshining on lower portions. Notum with two rather deep furrows and with a faint median one between, these terminate in a pitlike area just before the scutellum. Legs and abdomen black with dense black pile. *Wings*: Yellow fumose, costal cell and stigma brown, veins dark brown to black; vein R_{2+3} (R_{3+4}) gently curved into the costa.

"*Genitalia*: Ninth sternum broad, posterior lateral margins strongly produced, posterior median margin with a U-shaped concavity and a moundlike elevation in the middle. Harpagones rather sharply pointed, as seen from a ventral view (fig. 146a). Ninth tergum deeply concave, the cleft extending over one-half the length of the segment; with a broad, somewhat square protuberance in the center (fig. 146b).

"Length: body, 6-7 mm.; wing, 7-8 mm.

"**FEMALE.**—The reddish tinge is more pronounced and more extensive, marking off four opaque black stripes down the dorsum; pleurae entirely tinged; pile even more microscopic; antennae eleven segmented and the wings are more yellow fumose.

"Length: body, 8-9 mm.; wing, 9.5-10 mm."

Type locality: West border, Matto Grosso, Brazil.

Type in United States National Museum Collection.

Plecia (Plecia) incurvata Hardy

(Plate XXXIII, figs. 147a-c)

Plecia (Plecia) incurvata Hardy, 1942, Can. Ento. LXXIV, 110.

"This species belongs in the *confusa* complex but differs strikingly from all other species known to the writer. The male genitalia resembles *parvistylata* Hardy in having the posterior lateral margins of the sternum produced but the harpagones are more elongate and the ninth tergum more deeply concave (fig. 147c) but not developed clasperlike as in *confusa* Loew. The compound eyes are distinctly divided into upper and lower portions by a partitioning line or groove running across the middle. This is the first time the writer has observed this character in the *confusa* complex. The wing venation is also distinct in this species.

"MALE.—*Head*: Antennae entirely black, consisting of ten segments, including a nipplelike tip. Rostrum slightly over one-half the length of the antennae. Mesonotal furrows not so deep as in *parvistylata*. *Wings*: Vein R_{1+2} merging with R_{3+4} at its tip, far removed from the end of the subcostal vein; R_{3+4} arising vertically to the costa. Fork of media situated at about basal one-fourth of the distance between r-m crossvein and the fork of the radial sector. Vein R_5 strongly curved inwardly toward anterior margin behind the fork of the R_s (fig. 147b). Wings dark brown fumose on costal margin, stigma barely discernible from the membrane. *Genitalia*: Ninth sternum moderately concave medianly on hind margin, posterior lateral margins developed into clublike lobes (fig. 147a). Harpagones rather small, elongate and projecting inward, usually only bases visible from ventral view (those figured in fig. 147a are slightly out of position to show their shape). Ninth tergum deeply cleft, about three-fourths its length (fig. 147c); tergum extending much beyond hind margin of the ninth sternum.

"Length: body, 5.5 mm.; wing, 6.5-7 mm.

"Female unknown."

Type locality: Guadeloupe Island, West Indies.

Type in the United States National Museum.

Plecia (Rhinoplecia) lateralis Hardy

(Plate XXXIII, figs. 148a-c)

Plecia lateralis Hardy, 1940, Journ. Kan. Ent. Soc. 13: 18-19.

Following is the original description:

"This species is near *grisea* Edwards separating most conveniently by use of the male genitalia; the antennae of the male are nine

segmented instead of eight, the furrows of the notum more distinct, humeri and scutellum not reddish tinged, vein R_{2+3} (R_3) more vertical, the occiput is densely black haired, the sternopleurite with conspicuous dark hairs above and the abdomen dark haired.

"MALE.—In addition to the above, the rostrum is very thick and pronounced, slightly shorter than the antennae. *Thorax*: Notum rather evenly gray pruinose, slightly more grayed in the furrows and on the margins. Pleurae opaque brown to black; legs and abdomen brown; halteres brownish yellow. *Wings*: Brown fumose, stigma concolorous with the membrane. Vein R_1 (R_{1+2}) ending beyond the middle of the distance from subcosta to vein R_{2+3} ; R_{2+3} almost vertical with but a very slight curve near base; fork of media situated just before middle of distance from r-m crossvein to the fork of R_s .

"*Genitalia*: The ninth sternum is broader than long, with a troughlike concavity in the middle on the hind margin, posterior lateral margins not produced. The harpagones are rather long, appearing simple from ventral view, and more lateral in their position (fig. 148a); in this respect they are more like *Penthetria* than any other *Plecia* which have been observed. From a lateral view an inward developed process can be seen near their bases (fig. 148b). Ninth tergum with a slight convexity in the middle on hind margin (fig. 148c). Entire genitalia densely haired.

"Length: body, 5.5 mm.; wing, 5.5 mm.

"Female unknown."

Type locality: San Miguel, Hidalgo, Mexico.

Type in Cambridge Museum of Comparative Zoölogy.

Plecia (Rhinoplecia) lindneri Edwards

(Plate XXXIII, figs 149a-c)

Plecia lindneri Edwards, 1931, Konowia, Bd. X, Heft 1, 75-76.

This species belongs in the *collaris* group by having the anterior portion of the mesonotum blackish, the dorsum of the thorax being otherwise rufous. It is very characteristic in that the thorax is entirely opaque instead of shining and the genital structures are distinctive.

The following is the original description:

"Head blackish, but considerably dusted with gray. Eyes almost or quite bare in both sexes. Ocellar tubercle large. Few or no hairs on face near antennae or on clypeus. Antennae with scape and basal half of first flagellar segment ochreous-brown, rest darker brown; flagellum 5-segmented in male, 8-segmented in female. Mouth-parts

(with clypeus) bent backwards at rest, almost as long as head. Thorax dull, with gray dusting over the whole surface; colour of integument (beneath the gray pollen) mainly red above, but with a large blackish area on front of mesonotum, pronotal angles remaining reddish. Scutellum in male with a black median line. Pleurae mainly blackish and almost bare; a few very short reddish-brown hair. Hypopygium of male normal in size, ninth tergite with a shallow median emargination forming two rounded lobes. Legs dark brownish, femora lighter except towards tips; pubescence short. All femora rather short, but slender except towards tips; all tibiae slender. Wings smoky, somewhat darker in costal cell, stigma indistinct. Venation normal. Halteres with reddish stem and black knob."

Length of body, 6-7 mm.; wing, 7.5-9 mm.

The following description of the male genitalia is added: The ninth sternum is much longer than wide with the posterior median margin greatly developed beyond bases of harpagones; the posterior lateral margins are not greatly produced. The harpagones are strong, elongated and bluntly tipped from ventral view, plainly visible and extending slightly beyond the apex of the ninth segment (fig. 149a); from lateral view the harpagones are seen to possess two acute teeth on inner edges (fig. 149b). The internal apodemes are well developed and simulate secondary lobes of the harpagones. From lateral view, looking into the genital chamber, their apices are heavily sclerotized and may actually serve as clasping structures. The ninth tergum has a moderately V-shaped concavity on hind margin (fig. 149c).

Type locality: El Cairo, Northwest, Santa Cruz de la Sierra, Bolivia.

The writer has identified the species from West border Matto Grosso, Brazil, May 31 (R. C. Shannon) and Asupisu to Miriantiriani, Cam. del Pichia, Peru, July 9, 1920 (Cornell Exped. Lot 607, Sub. 132).

Plecia (Rhinoplecia) lopesi Hardy

(Plate XXXIII, figs 150a-c)

Plecia lopesi Hardy, 1940, Journ. Kan. Ent. Soc. 13, 19-20

This species is related to *bicolor*, but is readily distinguished by the genital characters. The specimens are of larger size than *bicolor* and the wings are darker fumose; the dorsum of the thorax is not so shining and that of the male is tinged with brownish. Following is the original description of the male genitalia:

Male genitalia: Ninth sternum with a sharp triangular shaped projection in the middle on its posterior edge, posterior lateral margins not greatly developed, claspers broad and rather sharply pointed from ventral view (fig. 150b). Ninth tergum gently and broadly concave on posterior margin (fig. 150c)."

Length: body, 6.5-7 mm.; wing, 7.5-8 mm.

Female.—Specimens slightly larger in size, dorsum of thorax more brightly colored; the pleurae slightly tinged with reddish and the antennal segments more compacted. Otherwise like the male.

Length: body, 7 mm.; wing, 9-9.5 mm.

Type locality: Eug. Lefevre, San Paulo, Trav., Brazil.

Type in Snow Entomological Collection.

Plecia (Rhinoplectia) maculata Hardy

(Plate XXXIII, figs. 151a-b)

Plecia (Rhinoplectia) maculata Hardy, 1942, Can. Ento. LXXIV, 110-111.

"This species approaches *rostellata* Loew in the development of the rostrum and its larger size but is very different from this species. The blackened pleurae and dark brown costal section of the wing together with its distinctive genitalia will separate it.

"**MALE.**—*Head:* Antennae black with a barely perceptible brownish tinge, eight-segmented, the last five segments of the flagellum almost round. Rostrum much longer than the antennae, mouth parts entirely black. *Thorax:* Opaque, mesonotum rufous with a median brown to black stripe extending backward from the anterior part of the dorsum, this is divided down the middle by a fine rufous line. Mesonotum also with a brownish discolored area on each side behind the middle. Scutellum with a black spot in the center. Pleurae chiefly brown to black with rufous markings on the hind portions of the sterno and mesopleurae and the middle of the pteropleurae. Knobs of halteres black, stems pale. Thorax entirely bare, with but microscopic pubescence. *Wings:* Brown fumose at base and on anterior margins, anterior veins dark brown. Posterior portion of wing almost hyaline, just slightly fumose. Vein R_{3+4} arising almost vertically into the costa (fig. 151c). Fork of media at about the basal one third to one fourth the distance between the r-m cross-vein and the fork of the Rs. Cu_1 sharply curved downward at its tip. Abdomen shining black with dense black pile. *Genitalia:* Ninth sternum large and very irregularly developed on posterior edge, posterior lateral margins produced into rather strong lobes. Harpagones of medium size with only bases visible from a ventral

view (fig. 151a), developed into a beaklike point on the inner side, as seen from a lateral view (fig. 151b). Ninth tergum deeply and narrowly concave, the cleft extending to about the basal one third of the segment (fig. 151d).

"Length: body, 8.5-9 mm; wing, 9 mm.

"Female unknown."

Type locality: W. Indies, E. Coast, Trinidad, Mayaro.

Type will be returned to the British Museum.

The species has also been recorded from Port of Spain, Trinidad.

Plecia marginata Edwards

Plecia marginata Edwards, 1920, Mission Arc. Meridien Amer. Sud. 10, 148.

The original description is in French, the following is a translation:

"Body 6 mm.-8 mm.; wing 11 mm.-13 mm. Head with its appendages dull black, scape of the antennae more pale. Thorax: mesonotum dull black with a narrow but continuous orange border; scutellum and postnotum orange; pleurae dark brown, more or less intermixed with brownish orange. Abdomen reddish brown above and below, clothed with short pale pubescence. Feet ochraceous brown; extremities of the femora, tibiae and tarsi dark brown, with blackish pile. Wings slightly brownish tinged, veins brown, stigma round, of a brownish gray color. Venation as in *P. nitidipes* Edwards. Stems of halteres ochraceous, knobs dark."

Described from Equador.

Type in British Museum.

The writer has not seen this species but it should be easily recognized by the orange border on the mesonotum and the reddish pleurae and abdomen.

Plecia (Rhinoplecia) maura Walker

(Plate XXXIII, figs. 152a-d)

Plecia maura Walker, 1837, Trans. Linn. Soc. London, XVII, 336.

Plecia velutina Macquart, 1844, Dipt. Exot. Suppl. 1, 149.

This is a very large entirely black species, the mouthparts are produced about as long as the antennae; antennae of male eight segmented, female eleven segmented. *Thorax*: Opaque, almost devoid of pile, with only a few microscopic yellow hairs, upper portion of sternopleurae likewise. Legs and abdomen subshining with dense black pile. *Wings*: Brown to black fumose, darker along costal margin, stigma only faintly discernible. Vein R_{3+4} short and almost vertical in male, longer, more oblique in female. *Male*

genitalia: The ninth sternum and harpagones are very much like those of *grisea* Edwards but the posterior lateral margins of the sternum are not so developed and the median protuberance is more acutely pointed, with a membranous swelling behind; hind median margin also more concave (fig. 152a). The ninth tergum is more deeply concave and no median development is present (fig. 152b).

Female genitalia: Ninth tergum broadly H-shaped, a narrow sclerotized bridge connecting the two lateral lobes of the segment. Cerci large, conspicuous and rounding (fig. 152d). Eighth sternum very characteristic in shape, posterior median margin produced into two pairs of strong lobes, the inner pair rounding and densely haired, the two outer lobes are sharply pointed from ventral view (fig. 152c), shining black and bare. From lateral view the outer lobes are greatly flattened and extended into the genital chamber to give support to the oviposition apparatus.

Male length: body, 8-9.5 mm.; wing, 9-11 mm.

Female length: body, 8.5-10 mm ; wing, 10.5-13 mm.

Type locality: Brazil.

Type in British Museum.

Specimens have been examined with Brasilien Nova Teutonia 27° 11' S. lat., 52° 23' W. long. (Fritz Plaumann); Parque do Estado S. Paulo, Oct. 25, 1934 (L. Trav.); Angra dos Reis Est. do Rio (D. Mendes); Angra-Jussara, Dec. 1926 Travassos and Otica (J. Lins); Petropolis, Rio de Janeiro, Brazil, Oct. 24-27, 1919 (Cornell Univ. Exped).

Plecia (Rhinoplecia) nearctica Hardy

(Plates XXXIII-XXXIV, figs 153a-e)

Plecia nearctica Hardy, 1940, Journ. Kan. Ent. Soc. 13, 20-21.

This species is related to *bicolor* Bellardi but the male genital structures are very distinctive, the bilobed harpagones and strong development of the posterior median margin of the ninth sternum separate it from other known species. Following is the original description of the male genitalia:

"Male genitalia: Ninth sternum somewhat narrowed distally with a small concavity on the posterior margin of the middle (fig. 153b). Claspers bilobed, both arms terminating in a beaklike point; the outer lobe is much stouter and vertical in position, visible from dorsal view; the inner lobe is smaller, more narrow and horizontal in position, directing inwardly and visible only from a lateral view

(fig. 153c); the claspers are densely haired. The ninth tergum is gently concave on the posterior margin (fig. 153a)."

Length: body, 4-5 mm.; wing, 4.5-5.3 mm.

Female genitalia: The eighth sternum terminates in a pair of rounding lobes, median cleft deep, extending almost to base of sternum; a sharp tooth is present on inside margin of each of the median lobes. A pair of sclerotized processes surround the vaginal opening, arising from the median portion of the genital chamber (fig. 153d). The ninth tergum is broad, its posterior margin with a deep U-shaped cleft (fig. 153e).

Length: body, 5-6.3 mm.; wing, 5.5-7.3 mm.

Type locality: Galveston, Texas.

Type in Snow Entomological Collection.

This species is widely distributed in the South, having been recorded from the following states and Central American countries: Costa Rica, Guatemala, Honduras, Louisiana, Mexico, Mississippi and Texas; apparently more common in Texas, Louisiana and Mississippi.

Plecia (Plecia) nigra (Philippi)

(Plate XXXIV, figs 154a-c)

Penthera nigra Phil., 1866, *Aufzählung der Chilenischen Dipteren*, Verh. Zool. Bot. Ges. Wien. v. XV, 639-640.

MALE.—Opaque black with a very characteristic vestiture of long black hair over the entire body, including the eyes. *Head:* Rostrum rather short, not one-half the length of the antennae. Antennae ten segmented, including the nipplelike tip. Compound eyes divided slightly below the median horizontal line, separating them into an upper and lower portion. Lower portion of eyes, occiput, face and ocellar tubercle densely haired. *Thorax:* Thickly haired on the dorsum, hypopleurae, middle of pteropleurae and upper portions of sternopleurae. Scutellum almost bare, only sparsely haired; halteres testaceous with blackish tinge. *Wings:* Yellow-brown fumose, veins dark brown, stigma but slightly darker than the membrane. Vein R_{3+4} oblique, scarcely curved (fig. 154a); fork of media situated before the middle of the distance from the r-m crossvein to the fork of the radial sector. *Genitalia:* Ninth sternum very irregular on hind margin, with three pairs of rounded lobes besides a median moundlike development; posterior lateral margins strongly produced, the median pair of lobes finely toothed on the inner margins (fig. 154c). Harpagones long and slender, folded downward into the

genital chamber in normal position. Ninth tergum gently concave, with a very prominent median process (fig. 154b).

Length: body, 4.7-5 mm.; wing, 6-6.2 mm.

Female unknown.

Type locality: Chile.

Type probably in the Santiago National Museum.

This is the only species of *Plecia* which has been recorded from Chile. The writer has examined a specimen from Corral, Valdivia, presented by the late Doctor Edwards of the British Museum.

Plecia (Rhinoplectia) nitidicollis Edwards

(Plate XXXIV, figs. 155a-c)

Plecia nitidicollis Edwards, 1931, Ann. Mag. Nat. Hist. Ser. 10, v. VII, 260-261.

Black species; rostrum greatly produced, longer than the antennae and equal to or longer than the head. *Thorax*: Mesonotum with three brightly shining stripes separated by opaque lines running down the notal furrows, median stripe undivided, median furrows very faint; chiefly bare with only sparse black hairs on the upper portion of the sternopleurae, lower portion of sternopleurae subshining. *Wings*: Brownish to smoky fumose, stigma faintly discernible; vein R_{3+4} gently curved into the costa; fork of media situated at about the basal one-third of the distance from the r-m crossvein to the fork of R_s . Hind tibiae clavate, posterior tarsal subsegments slightly swollen. *Male genitalia*: Ninth sternum broad, very faintly concave on hind margin. Harpagones broad, ending in two rather blunt points as seen from a ventral view (fig. 155b), produced inwardly into a large rounded lobe from a lateral view (fig. 155c). Ninth tergum with a slight concavity on hind margin and with a pair of inward projections in the middle (fig. 155a), these are triangular shaped as seen from an end view.

Length: body, 5-5.4 mm.; wings, 6-6.7 mm.

FEMALE.—The median stripe is sometimes divided by a faint grayish line down the middle furrow. Hind tibiae straight, all tarsi slender. The dorsum of the thorax is sometimes rather dull, only subshining. *Genitalia*: Ninth tergum about twice as wide as long, cleft one-third to one-fourth its length on both anterior and posterior margins; cleft of anterior margin broadly U-shaped, that of hind margin with a broad flat bottom and almost straight sides. From ventral view the eighth sternum is about twice as wide as long, the posterior median lobes not strongly developed; the sternum is divided into two plates by a median longitudinal cleft. A pair of

large black sclerotized plates occupy the ventral portion of the genital chamber just above the lobes of the eighth sternum; these plates are attached to the bases of the ninth tergum and probably serve as egg guides.

Species described from Castro, Parana, Brazil.

Type in the British Museum.

The writer has examined two paratopotypes; also specimens from the following localities: Eng. Lefevre (Est. de S. Paulo) I-XI-1937 (N. Santos-Lopes et Oiticica) and San Paulo-Cantareira (Serra), 7-9-1934 (S. Trav).

Plecia (Plecia) nitidipes Edwards

(Plate XXXIV, figs. 156a-d)

Plecia nitidipes Edwards, 1920, Mission Arc. Meridien Amer. Sud. 10, 147-148.

This species was described from females and the male has heretofore been unknown. All of the specimens of this complex that the writer has examined from Ecuador have belonged to one species and specimens of this series have been compared with the type by Doctor Edwards and declared to certainly belong to *nitidipes*.

MALE.—*Head*: Rostrum not developed, antennae ten segmented. *Thorax*: Entirely opaque, with short recumbent yellow pile on dorsum, erect brown to black hairs on upper portion of the sternopleurae, sides of mesonotum and area behind humeral ridges coarsely rugulose, mesonotum noticeably but not deeply furrowed. Legs and abdomen brown to black the latter with thin pale pile. *Wings*: subhyaline, but faintly smoky; fork of third vein (R_{3+4}) oblique, with a gentle curve into the costa; fork of media situated near the middle of the distance between the r-m crossvein and the fork of the Rs. *Genitalia*: Posterior margin of ninth sternum with two pairs of processes, two strongly developed lateral lobes and two median lobes; the area between the median lobes is concave with a small bump in the center. These processes are covered with strong hairs and bristles. Harpagones long and slender with a beaklike point on the inner apices (fig. 156a). The harpagones are folded down into the genital chamber in their normal position and usually cannot be seen from ventral view. The ninth tergum is deeply excavated on the posterior margin and possesses a characteristic pointed protuberence in the middle (fig. 156b). The genitalia of this species show that it is close to *plagiata* Wd. The only notable difference being the central toothlike projection of the tergum.

Length: body, 6-6.5 mm.; wings, 7.5-9 mm.

FEMALE.—Larger specimens, body 8.6 mm.; wings, 12 mm., antennae eleven segmented. *Genitalia*: Eighth sternum completely divided into two plates by a longitudinal median cleft, posterior margins produced into a pair of densely haired, rounded lobes (fig. 156c). Ninth tergum very broad and narrow, four times as wide as its greatest length; densely haired with a characteristic spinelike process in middle on hind margin (fig. 156d).

Described from Ecuador.

Type in British Museum.

Specimens have been examined from Quito, Ecuador, 2850 ft., (F. Campos); Canar, Ecuador, 2600, April (Lichtwardt); Cuicocha, 3300 m., Imbabura, Ecuador, May 27-31, 1939 (F. M. Brown); Cumbre Tililac, Chimborazo, 4200 m., Ecuad., June 21, 1939 (F. M. Brown); Urbina Cerra, Chimborazo, Ecuad. 3650 m., April 18, 1939 (F. M. Brown).

Plecia (Rhinoplectia) panamaensis Hardy

(Plate XXXIV, figs. 157a-d)

Plecia (Rhinoplectia) panamaensis Hardy, 1942, Can. Ento. LXXIV, 111-112.

"This species can be separated from *rufithorax* Walker only by the genital characters but these structures are so distinct that there can be no doubt of its identity, even in undissected specimens. The long processes on the hind margin of the ninth sternum will separate it readily from any species known to the writer.

"*Male genitalia*: Posterior margin of ninth sternum produced into two long outward projecting prongs with a deep V-shaped cleft between; on the outer margins of these median developments, just below their middles, a slender sclerotized rod extends underneath the apical margin of the segment to attach to the body wall at the bases of claspers (fig. 157c). These rods probably serve for muscle attachments. Harpagones rather strong, somewhat broadened apically, pointed inwardly on their apices from a ventral view. Posterior lateral margins of tergum slightly developed; segment broader than long, with a small V-shaped excavation in the middle on the hind margin, as seen from a dorsal view (fig. 157b). The tergum folds back on the posterior edge producing a broad flat area before the anal region. If the genitalia are tilted forward the ridges at the back will give a different perspective than the one figured.

'Length male: body, 5.2-5.8 mm.; wing, 6 mm.

"*Female genitalia*: Eighth sternum almost twice as wide as long, the posterior median pair of lobes rather acute and slightly concave

on inner margins; hind margin of each plate with a distinct concavity in middle and a broad rounding outer lobe (fig. 157a). Ninth tergum only twice as wide as its greatest length, deeply cleft on hind margin, with only a narrow strip of sclerite joining the two lateral plates (fig. 157d).

"Length female: body, 6.7 mm.; wing, 7.4 mm."

Type locality: Cano Saddle, Gatun L. Panama.

Type in the United States National Museum.

The species has also been recorded from the following localities in Panama: Boqueron River, Cabima, Tubernilla, Canal Zone and Barro Colorado.

Plecia (Plecia) parvistylata Hardy

(Plate XXXIV, figs. 158a-b)

Plecia (Plecia) parvistylata Hardy, 1942, Can. Ento. LXXIV, 112

"Related to *confusa* Loew but more closely approaching *incurvata* Hardy structurally. It separates from either of these by the shape of the ninth tergum and the harpagones.

"MALE.—Beak shorter than antennae and scarcely visible. Antennae nine segmented, brownish yellow. Thorax deep orange; the outside median furrows of the mesonotum are more deeply grooved and the legs more densely haired than any which have been observed in the *confusa* complex. The legs are shining black and very densely covered with long black hair. *Genitalia*: Ninth sternum gently concave on the posterior margin, posterior lateral margins rather strongly developed into knoblike lobes; harpagones very small and folded inwardly, pointed on the outer apical edge (fig. 158a). Ninth tergum only moderately concave with a strong median projection on hind margin (fig. 158b).

"Length: body, 4.5-5 mm.; wing, 6 mm.

"Female unknown."

Type locality: Antigua, Guatemala.

Type in the United States National Museum.

Plecia (Rhinoplecia) perplexa Hardy

(Plate XXXIV, figs. 159a-d)

Plecia (Rhinoplecia) perplexa Hardy, 1942, Can. Ento. LXXIV, 112

"Related to *bicolor* Bell. and *collaris* (Fabr.) but easily separated by the unusual development of the male genitalia. The male has a small black area on the anterior portion of the dorsum placing it in the *collaris* group but in the female this is but faintly darkened.

"Male genitalia: Ninth sternum wider than long, longest on a

median line, with two moderate developments on hind margin near median portion. Between these median lobes is a slightl, convex area. The posterior lateral margins of sternum are scarcely produced. Harpagones broad at their bases, each terminating in a narrow fingerlike development apically, minutely shagreened on inner surfaces. A clasperlike process projects outward from each side of the aedeagus, developed almost as long as the harpagones and plainly visible from ventral view (fig. 159c). These are apparently accessory lobes of the aedeagus and appear to be attached to this organ by membrane along their inner sides, however, they terminate basally in two appendages which might serve for muscular attachments (fig. 159d), suggesting that they are possibly functional as clasping structures. Ninth tergum with a V-shaped excavation on posterior margin, from a dorsal view (fig. 159a); the hind margin is folded inward and developed into two rounded lobes as seen from an end view (fig. 159b).

"Male length: body, 4.3 mm.; wing, 4.8 mm.

"Female length: body, 4.3 mm.; wing, 5.5 mm."

Type locality: Cuba, 226 (Loew).

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Type in Cambridge Museum of Comparative Zoölogy.

The species has also been recorded from Buenos Aires, Trinidad Mts., Cuba.

Plecua (Rhinoplecua) persimilis Hardy

(Plate XXXV, figs 160a-e)

Plecua persimilis Hardy 1940, Journ. Kan. Ent. Soc. 13, 21-22

This species is related to *seminitens* Edwards but has the wings yellow to yellow-brown fumose instead of dark smoky fumose and the legs are more consistantly rufous tinged. The posterior median margin of the ninth sternum is not produced as in *seminitens* and the harpagones are more acute apically. Harpagones bilobed, as seen from ventral view (fig. 160a), the inner lobe is small, sharply pointed and situated just beneath the large outer lobe; this inner lobe is not visible from lateral view (fig. 160b). The posterior lateral margins of the ninth sternum are not produced and the median margin possesses a small U-shaped cleft. Ninth tergum somewhat produced on posterior median margin into a flat topped development (fig. 160d).

Length: body, 3.5-4.6 mm.; wing, 5.5-6.4 mm.

Female genitalia: Eighth sternum over two times as wide as long,

posterior median lobes well developed and rounding (fig. 160c). The ninth tergum is about three times as wide as long, rounding on the sides and with a broad deep cleft on hind margin, the bottom of this cleft is somewhat undulated (fig. 160e).

Length: body, 6-6.7 mm.; wing, 8 mm.

Type locality: Sao Paulo, Cantareira, (Serra) Brazil.

Additional topotypes have been studied.

Type in the United States National Museum.

Plecia (Plecia) pertinens Hardy

(Plate XXXV, figs 161a-g)

Plecia (Plecia) pertinens Hardy, 1942, Can. Ento. LXXIV, 112-113

"This species is related to *confusa* Loew in having the rostrum shorter than the head and thorax entirely yellowish to orange-red and possesses only minor differences other than those of the male genitalia. The antennae of the male are nine segmented, the upper portions of the sternopleurae are pale haired. The fork of the radial sector (vein R_{3+4}) slightly bent in the middle (figs. 161e, f), not so nearly straight as in *confusa*. Vein R_{1+2} ending about half way between the end of the subcostal vein and R_{3+4} not ending close to this vein as in *confusa*. In the allotype the bend in R_{3+4} is closer to the base of the vein and R_{1+2} is still more remote from this vein (fig. 161f).

"*Male genitalia*: Ninth sternum wider than long, posterior lateral margins developed into two rather strong lobes (fig. 161a), with a convexity in the depression. Harpagones very small and undeveloped appearing rather obtuse from a ventral view. From a lateral view the harpagones are developed into a small point on inner apices (fig. 161c). Ninth tergum concave on posterior margin with a heavily sclerotized, blunt protuberance in the middle (fig. 161b).

"Male length: body, 5.3 mm.; wing, 6 mm.

"*Female genitalia*: Eighth sternum with a U-shaped cleft extending two-thirds the length of the segment, posterior median lobes well developed and rounding, outside of these and extending dorsally in toward the genital chamber are a pair of long, slender lobes (fig. 161d), these probably serve as egg guides. The ninth tergum is twice as wide as its greatest length with a broadly V-shaped cleft extending three-fourths its length on hind margin (fig. 161g).

"Female length: body, 6.5 mm.; wing, 7.5-8 mm."

Type locality: Venta de Zopilote, Guerrero, Mex., 2800 ft., Oct.

Type to be returned to the British Museum of Natural History. At present in the Snow Entomological Collection.

The species has also been recorded from State of Colima, Mexico. Guatemala City and Moca, Guatemala. Also from Tegucigalpa, Honduras.

Plecia (Rhinoplecia) pictipennis Edwards

(Plate XXXV, figs 162a-c)

Plecia pictipennis Edwards, 1931, Ann Mag Nat Hist. Ser 10, V VII, 260

This species is easily distinguished by its wing markings, the following is the original description:

"*Head* dark grey, heavily pruinose. *Antennae* black (damaged in all specimens). *Mouth-parts* black shorter than head, but bent back beneath head as in other species of the subgenus *Rhinoplecia*. *Thorax* with ground-colour dark ochreous-grey, heavily pruinose. *Mesonotum* with three conspicuous shining black stripes, middle stripe divided by a narrow dull grey line. *Abdomen* dull black. *Hypopygium* of male mainly formed of the large sternite, which extends even to the dorsal surface; tergite small, quadrate, with one shining black triangular projection in middle. *Legs* short and stout, dark reddish brown, tip of tibiae and tarsi blackened; hind femora much thickened on apical half. *Wings* smoky, scarcely darker towards costa except on stigma. A conspicuous pale yellow fascia across middle of wing from R_1 to tip of Cu_2 , broadening out towards base of wing at m-cu, and just extending into lower basal cell; another pale yellow area at base of anal cell, including the angle. *Halteres* with ochreous stem and black knob.

"Length of body 5-5.5 mm.; wing, 6.5-7.5 mm."

The following description of the male genitalia should be added to this: Ninth sternum very broad, the lateral margins curving around and meeting the ninth tergum on the dorsal side of the segment, occupying as much of the dorsum as the short tergum (fig. 162c). This is the only time the writer has observed this character. Posterior lateral margins of sternum densely matted with short black hair, median portion strongly convex. Harpagones very irregular and appearing somewhat flat topped from ventral view and acutely pointed apically from a lateral view (figs. 162a, b). Because of the irregularity of this structure it is possible to see different perspectives than the ones shown in the figures, depending on the particular angle from which it is viewed. Ninth tergum very small compared with the sternum. The lateral margins of the sternum occupying about one-half the area normally covered by the

tergum. Tergum developed into an acute heavily sclerotized point medianly on posterior margins (fig. 162c). Lateral margins densely haired.

Type locality: Brazil, Castro, Parana.

The writer has examined a paratype male from the British Museum.

Plecia pictipennis var. *rufovittata* Edwards

Plecia (*Rhinoplecia*) *pictipennis rufovittatus* Edwards, 1938, Ann. Mag. Nat. Hist. Ser. 11, No. 10, 323.

This differs from the typical variety in having the stripes of the dorsum reddish instead of black.

Specimens have been examined from the type locality, Nova Teutonia, Brazil. Type in British Museum.

Plecia (*Plecia*) *plagiata* Wiedemann

(Plate XXXV, figs. 163a-d)

Plecia plagiata Wiedemann, 1824, Analecta Entom. p. 11.

Plecia funebris Fabricius?, 1806, Syst. Antl. 54, 14.

Plecia heteroptera Macquart, 1845, Dipt. Exot. Supl. 1, Mem. del. Soc. Roy. De Lille.

Plecia vittata Bellardi (nec Wiedemann), 1862, Ditt. Mess., Torino App. 7, 4. *P. bellardi* Townsend, 1912, Can. Ento. 44, 289. (?)

The type of *funebris* has been lost and the original description is inadequate but it is probably the same as *plagiata* Wiedemann, but as the identity of the latter is more positive it is better to use this name.

Townsend states that he believes Schiner's synonymy is incorrect and that *vittata* Bellardi is distinct and as that name was preoccupied by Wiedemann's *vittata* he proposes the new name *bellardi*. He gives no specific reason for his assumption except "there is no brownish tinge to the wings, which vary from a dense to a dilute black, with an iridescent greenish to violent reflection in oblique lights. Wiedemann describes the darker parts of the wings of *plagiata* as blackish brown. Schiner gives no reason whatever for placing *vittata* Bell, as a synonym of *plagiata*." The variations in the wing fumosity have been seen to cover the characteristics given by Townsend. The writer has attempted to obtain a specimen of Townsend's series, but the late Doctor E. P. Van Duzee stated in correspondence: "The Diptera in the California Academy of Science collection were destroyed by the San Francisco fire, following the earthquake and were lost."

P. plagiata is an easily distinguished species with a wide range of distribution in the Neotropical region.

MALE and FEMALE.—Entirely black species. *Heau.* Rostrum produced but much shorter than the head or antennae. Antennae of male ten-segmented, that of female eleven. Palpi equal to antennae in length. *Thorax:* Entirely opaque black. Mesonotum with two rather deep longitudinal furrows and no apparent median furrow. Notum with sparse recumbent yellow pile. Pleurae chiefly bare except for the brownish hairs on the upper half of sternopleurae. Legs and abdomen densely covered with black pile. *Wings:* With dark brown bands along the veins, leaving the inner portions of most of the cells hyaline. The costal, subcostal and cell R_4 entirely brown. Radial cell (first basal) brown except for a small hyaline spot at the base; all other cells have a clear area in the center. Fork of third vein (R_{3+4}) arising almost vertically into the costa, merging with R_{1+2} at its tip. *Male genitalia:* Posterior lateral margins of ninth sternum greatly produced. Hind margin with two developments. Harpagones long and slender (fig. 163a), folding down into the genital cavity in normal position. Ninth tergum deeply concave, almost separated into two parts, without a central toothlike process (fig. 163b).

Female genitalia: Eighth sternum almost completely divided by a median cleft, only a narrow sclerotized bridge joins the two on anterior edge. The posterior margins are produced into a pair of rounded lobes, at the outer base of each of these is a shallow depressed area (fig. 163c). Ninth tergum three times as wide as its longest portion; with a deep, broadly U-shaped concavity on hind margin (fig. 163d). Cerci almost oval, densely haired.

Length: body, 6-7 mm.; wing, 7-9.3 mm.

Described from Brazil; type in Copenhagen.

Two specimens from type series have been examined. The species is very abundant in the American tropics, having been examined from the following areas: Brazil, British Guiana, Colombia, Costa Rica, Dutch Guiana, Honduras, Mexico, Panama, Peru, and Venezuela. Edwards also records this from Nicaragua and Guatemala.

Plecia (Rhinoplecia) pruinosa Hardy

(Plate XXXV, figs. 164a-b)

Plecia pruinosa Hardy, 1940, Journ. Kan. Ent. Soc. 13, 22-23.

This species is related to *grisea* Edwards but the distinctive genital structures of the male will distinguish it from all known species. The rostrum is more elongate than in *grisea*, the femora are pale basally, halteres are black and the wings smoky brown fumose. Following is the original description of the male genitalia:

"Genitalia: Posterior margin of ninth sternum developed into a pair of heavily sclerotized, outward projecting, clasper-like lobes and a pair of smaller, rounded lobes on posterior lateral margins. Harpagones comparatively small and situated toward the middle of the sternum, scarcely visible from ventral view, arising from behind the membranous area and with two acute points apically (fig. 164a). Tergum with a V-shaped excavation in the middle of the hind margin, two obtuse points curving inwardly at apex of tergum (fig. 164b); the hind margin is developed into a broad strongly sclerotized shelf-like area extending into the genital chamber, probably giving support to the anal area."

Length: body, 4.5 mm.; wing, 5.2 mm.

"Female.—The scape, pedicel and bases of first flagellar segments are yellow; the entire thorax is faintly yellowish tinged, the margins and humeral ridges are distinctly yellow, as are the trochanters and femora; otherwise like the male.

Length: body, 4.6 mm.; wing, 5.6 mm "

Type locality: Pico Turquino, Cuba.

Type in Cambridge Museum of Comparative Zoölogy

Plecia (Rhinoplecia) punctulata Hardy

(Plate XXXV, figs. 165a-b)

Plecia punctulata Hardy, 1940, Journ. Kan. Ent. Soc. 13, 23-24

Following is the original description:

"Somewhat related to *nitidipes* Edwards but differing in a great many respects. The rostrum is developed as long or longer than the antennae; the dorsum is covered with minute punctules; the ninth sternum is not developed into two pairs of lobes on hind margin and the posterior lateral margins not at all produced; the tergum is not so deeply concave and the lateral margins are developed into a pair of narrow lobes posteriorly (fig. 165a).

"Male.—In addition to the characters given above: Entirely black, opaque to subopaque, dorsum sometimes in part shining and usually appearing faintly pruinose, especially on the margins. This appearance is caused by the finely punctulate texture. Stems of halteres yellow-brown, knobs brown to black. *Wings:* yellow-brown fumose, veins and stigma brown; vein R_{2+3} (R_{3+4}) gently curved into the costa; crossvein r-m situated at about the middle of the distance between m-cu and fork of media.

"Genitalia: Ninth sternum scarcely developed on hind margin, only two small swellings toward the middle. Harpagones elongate and strong, produced about as long as the sternum and rather

abruptly tapering on the inner margins near their apices (fig. 165e). Ninth tergum divided into two halves by a median groove or invaginated area; posterior lateral margins produced into a pair of narrow lobes; median margin with a strong pointed process (fig. 165a) which folds inward toward the genital chamber.

"Length: body, 3.2-3.6 mm.; wing, 3.7-4 mm.

"*Female*.—The stigma is concolorous with the wing membrane, vein R_{2+3} (R_{3+4}) more oblique, curved but slightly near its base; antennae eleven segmented; humeral ridges and hind margins of mesonotum tinged with rufous; otherwise like the male, except for sexual characters.

"Length: body, 4-4.3 mm.; wing, 4.6-5 mm."

Type locality: Diamantina, Minas Geraes, Brazil.

Type in Cornell University Collection.

Plecia (Rhinoplecia) quadrivittata Williston

(Plate XXXVI, figs. 166a-e)

Plecia quadrivittata Williston, 1900, Bio. Cent. Amer. III, Suppl. I

This appears to be a rather common species in the states of Guerrero and Colima in Mexico. The writer has examined a large series which fits the original description. Williston's description is very complete with the exception of the male genitalia. The original is quoted: "*Male*. Black throughout. Head lightly gray-pollinose; face prolonged in front of the eyes about as far as the vertex projects backwards; eyes elongate oval, the ocellar tubercle prominent. Thorax and scutellum lightly dusted with grayish, opaque, the mesonotum with four shining black stripes, the lateral ones abbreviated in front, the narrowly separated median ones behind. Abdomen moderately shining. Wings uniformly brown; the anterior branch of the third vein is at an angle of about forty-five degrees, arising nearly opposite the end of the second vein and terminating in the costa a little less than its own length from the tip of the second vein; penultimate section of the third vein a little longer than the length of the anterior cross-vein; furcation broad in the margin; anal cell wide open. Proboscis longer than the distance from the vertex to the lower end of the face. Length 6-7 millim.

"*Female*. Larger; abdomen opaque brownish-black."

Male genitalia: Ninth sternum with a blunt median process on hind margin, posterior lateral margins moderately produced. Harpagones simple, folded inward in normal position, rather acutely pointed (fig. 166b). Accessory structures of aedeagus rather complex (fig. 166c). Ninth tergum cleft about one-half the length of

the segment, the lower portion of the cleft is very narrow (fig. 166d).

Female genitalia: Eighth sternum broad, heavily sclerotized on posterior portion, more lightly so on anterior half. Posterior margin produced into two strong lobes near middle, with two small median developments between and a large rounding swelling at each side (fig. 166a); sternum divided into two plates by the median cleft. Ninth tergum concave on hind margin, posterior lateral margins rounding. Anterior lateral margins strongly produced into a long sclerotized process which extends beneath the eighth abdominal tergum (fig. 166e).

The species was described from Rincon, Guerrero.

The writer has examined a large series from Cuernavaca, Mexico, Oct. 22, 1922 (E. G. Smyth), and Colima, Vulcano, Mexico (L. Conrad).

Cotypes in British Museum collection and American Museum.

Plecia (Rhinoplecia) rectiora Hardy

(Plate XXXVI, figs 167a-c)

Plecia (Rhinoplecia) rectiora Hardy, 1942, Can. Ento. LXXIV, 118

"The mouthparts of this species are intermediate between *P. confusa* Loew and *rufithorax* Walker. They are about equal to the antennae in length, the mesonotum is only faintly furrowed and the legs and abdomen are brown with a faint reddish tinge. The species, however, can be separated conveniently only by using the male genitalia; these structures differ from any other species in the complex.

"Genitalia: Ninth sternum more strongly produced on the posterior lateral margins, these lobes extend beyond the median edge of the segment about three-fourths the length of the harpago. Harpagones simple, pointed apically (fig. 167a); accessory plates at each side of aedeagus large and well developed, each with a strong outward projecting spine on outer margin near apex (fig. 167b) as seen in end view. Ninth tergum with a broad flat bottomed excavation on the hind margin, this cleft has a very minute niche in middle as seen from dorsal view (fig. 167c). The hind margin of the tergum is folded over into the genital chamber, broadly produced, rounded on the sides and developed into an inward projecting point from end view.

"Length: body, 5.5-6 mm.; wing, 7.4 mm.

"Females are slightly larger in size, body, 7-7.4 mm.; wing, 9-10 mm."

Type locality: S. Luiz Ricamar, Est Maranhao, Brazil.

Type in Snow Entomological Collection.

The species has also been recorded from Sapucay and Viñica, Paraguay.

Plecia (Rhinoplecia) rostellata Loew

(Plate XXXVI, figs. 168a-d)

Plecia rostellata Loew, 1858, Berl. Ent. Zeit. II.

Plecia rostrata Bellardi, 1859, Ditt. Mess. 1, 15, 3 (Syn. by Schiner).

The specimens described here fit the original description and the wing figured by Loew and no doubt belong to the species he had in mind. The description of the species was based upon the female so it is difficult to be absolutely sure of its identity, this is the only Brazilian form known to the writer which conforms entirely to Loew's description.

MALE.—*Head*: Rostrum produced as long as the head, longer than the antennae; antennae eight segmented, yellowish with a light brown tinge toward the apical segments; the segments are proportioned as in most other members of the genus. *Thorax*: Entirely yellowish orange; halteres yellowish at their bases, black at their tips. Legs and abdomen brown to black with dense short black hairs. *Wings*: Yellow-brown fumose, costal cell and stigma brown. Fork of radial sector (vein R_{3+4}) arising at end of R_{1+2} and extending almost vertically into the costa. Fork of media located at about one-third the distance from the r-m crossvein to the fork of the Rs. *Genitalia*: Ninth sternum with a convex rounded projection in the middle on the hind margin, posterior lateral margins rather strongly developed but much less than one-half the height of the claspers. Harpagones broad and rather blunt from a ventral view (fig. 168c). Ninth tergum deeply but gently concave on posterior margin; tergum widest at upper one-fourth of the segment (fig. 168d); hind margin not developed as in *gibbosa* Hardy.

Length: body, 6-6.5 mm.; wing, 7-7.5 mm.

FEMALE.—Fits the description of the male (aside from sexual characters) with the exception of the eleven segmented antennae (counting nipplelike tip); the antennae are also darker brown and the specimens are larger. *Female genitalia*: Eighth sternum divided into two plates by median cleft, posterior median lobes rounding and slightly convergent; lateral lobes acutely pointed and arising very close to median lobes; sternum much wider than long (fig. 168a). Ninth tergum deeply cleft on hind margin, this cleft is flat

bottomed and the lateral lobes are broad and rounding; anterior lateral margins produced inwardly into a pair of long projections (fig. 168b).

Length: body, 6.5-7 mm.; wing, 8.5-9.5 mm.

Type locality: Brazil.

Type probably in the Zoölogical Museum at Berlin.

Specimens have been examined from Rio de Janeiro, Brazil, L. Trav., May, 1935 (Lopes), and June 20, 1918 (R. Flacher); Diamantina, State of Minas Geraes, Brazil, Nov. 14-18, 1919 (Cornell University Exped.) and Aqua Preta, Bahia, Brazil, 12-8-39 (Pedrito Silva).

Plecia (Rhinoplecia) rufimarginata Hardy

(Plate XXXVI, figs. 169a-b)

Plecia rufimarginata Hardy, 1940, Journ. Kan. Ent. Soc. 13, 24.

This species is related to *edwardsi* Hardy but the rostrum is as long as the antennae and the male genitalia are very different. The pleurae, margins of mesonotum and legs of both sexes are lightly yellowish tinged. The fork of media is at about half the distance between r-m crossvein and fork of Rs, instead of near basal third as in *edwardsi*. This is the smallest *Plecia* known to the writer. Following is the original description of the male genitalia:

"*Male genitalia*: Ninth sternum slightly wider than long, posterior margin concave, with three median projections; the two lateral ones are heavily sclerotized, vertical in position and densely haired; the median is more membranous and projects inward toward the genital chamber and is bare (fig. 169b). The harpagones are simple and terminate in an acute point on the inner margins. Ninth tergum with but a single concavity on posterior margin (fig. 169a)."

Male length: body, 2.1-2.3 mm.; wings, 2.6 mm.

Female length: body, 2.6-2.7 mm.; wings, 3.2 mm.

Type locality: Paraiso, Panama.

Type in the United States National Museum Collection.

Plecia (Rhinoplecia) rufiscutella Hardy

(Plate XXXVI, figs. 170a-b)

Plecia rufiscutella Hardy, 1940, Journ. Kan. Ent. Soc. 13; 24-25.

The male genitalia places this species near *nitidipes* Edwards. It is easily recognized by the bright orange-red scutellum of both sexes. The rostrum is more elongate, the wings differ and the genital characters are distinct from *nitidipes*. Following is the original description:

"Male.—Head: Rostrum produced longer than the head, antennae broken on holotype specimen. **Thorax:** Opaque black with a faint reddish tinge on the lateral margins; scutellum bright orange-red. Almost bare species, with only brown hairs on the upper portions of the sternopleurae and a dense patch of black hair on each humerus. Mesonotal furrows very faint, sides and hind portions of notum rugose; the rugosity appearing in sunken areas, one on each side and one just before the scutellum. Legs and abdomen subshining black with black pile; halteres black. **Wings:** The wing venation is much the same as in *plagiata* Wiedemann but the fumose borders of the veins are more yellow and not so dark. Vein R_{2+3} (R_{3+4}) gently curves into the costa. R_1 is situated two-thirds the distance between subcosta and R_{2+3} (R_{3+4}); fork of media at or slightly beyond one-half the distance from the r-m crossvein to the fork of R_s .

"Genitalia: Ninth sternum very broad and rather long, posterior lateral margins produced into two large flat-topped lobes, posterior median margin with two narrow processes. Harpagones very slender and elongate, vertical in position (fig. 170b). Ninth tergum concave on hind margin, posterior lateral margins with a distinct emargination, anterior margin very deeply cut inward almost dividing the segment (fig. 170a); cerci very broad and rounding.

"Length: body, 7.5 mm.; wing, 9.5 mm."

"Female.—Antennae eleven segmented, thorax brownish with a faint shade of red; scutellum yellow-orange; legs slightly reddish tinged, otherwise like the male.

"Length: body, 8-9 mm.; wing, 12 mm."

Type locality: Moyombamba Region, Peru.

Type in the American Museum.

Plecia (Rhinoplecia) rufithorax Walker

(Plate XXXVI, figs. 171a-d)

Plecia rufithorax Walker, 1848, List of Dipt. in Brit. Mus. I. 116.

This species has also caused a great deal of controversy in that it has long been common practice to place almost all Neotropical *Plecia* of medium size, long rostrum and rufous thorax under this name. Walker's type was a female from Jamaica and all the males the writer has examined from this island have been conspecific. Doctor Edwards has also compared females with the type, so the species here described is no doubt *rufithorax*.

MALE.—Head: Rostrum produced as long as the head and longer than the antennae, antennae eight segmented; the pedicel, scape and basal one-half of first flagellar segment yellow, otherwise brownish

yellow; ocellar tubercle very prominent. *Thorax*: Entirely yellowish to orange-rufous. Mesonotum sometimes lightly speckled with brownish; notum with two distinct longitudinal furrows, and one faint median furrow, the lateral ones converge slightly before the scutellum. Halteres with brown knobs and yellow stems. Legs and abdomen brown to black with black hairs. *Wings*: Brownish yellow fumose, stigma but little darker than the membrane, veins brown. Fork of radial sector (vein R_{3+4}) arising just beyond the end of R_{1+2} and extending almost vertically into the wing margin (fig. 171c). Fork of M_1 and $_2$ at about basal one-third of distance between the radio-medial crossvein and the fork of the radial sector. *Genitalia*: Ninth sternum slightly broader than long with a median process on hind margin, this process terminates in two small lateral projections with a small depressed area between. Posterior lateral margins of sternum only slightly developed. Harpagones broad and flat apically ending in two points (fig. 172a). Ninth tergum with an almost rectilinear excavation on hind margin, the sides and bottom of this area but slightly rounded (fig. 171b).

Length: body, 4.6-5.4 mm.; wing, 5.5-6 mm.

Female genitalia: Ninth tergum about three times as wide as long with a broadly U-shaped cleft on hind margin and a slight convexity in the middle of this cleft; posterior lateral margins somewhat undulated (fig. 171a). Eighth sternum divided into two plates by a median cleft, median lobes elongated and pointed apically, posterior lateral margins wavy, lateral lobes rounded (fig. 171d).

Female length: body, 5.5 mm.; wing, 6-6.7 mm.

Described from the Island of Jamaica.

Type in British Museum.

The writer has studied specimens from the type locality.

Plecia rufithorax concava Hardy

(Plate XXXVII, figs. 172a-f)

Plecia rufithorax concava Hardy, 1942, Can. Ento. LXXIV, 114.

"The specimens here discussed are considered a subspecies of *rufithorax* because of the apparent close relationship shown in the genital structures of both sexes. The males differ chiefly in having the ninth tergum moderately concave, broadly U-shaped on hind margin (fig. 172d). The ninth sternum and harpagones appear to be identical (fig. 172a). The female genitalia show considerably more differentiation than those of the male. The cleft of ninth tergum is broadly U-shaped on hind margin (fig. 172e) instead of being wide and flat bottomed as in typical *rufithorax* and the posterior

lateral margins of the tergum are broadly rounded, not indented. The tergum is almost twice as wide as long. Eighth sternum developed into two prominent lobes near middle on hind margin, these are characteristically notched on their outer margins (fig. 172f). Specimens of both sexes are also of larger size than the typical *rufithorax*, the female of *concava* being almost twice as large.

"Length: male body, 6 mm.; wing, 6.7-8 mm.

"Female: body, 7.4-8.6 mm.; wing, 9.4-10.7 mm."

Type locality: * Holotype male and allotype female on same pin, Cacao Trece Aguas, Alta V. Paz, Guatemala, Aug. 4, '06 (Schwarz-Barber.) Paratypes: One female, same data; one male Cayuga, Guat., April 1915 (Wm. Schaus); one male, one female, Orizaba, Mexico (Mann); four males, one female, Tegucigalpa, Honduras, April-June, 1917-18 (F. J. Dyer); one male, same locality, June 6, 1909; one female, La Cieba, Brit. Honduras, Oct. 18, 1916 (F. J. Dyer); one male, Rep. Honduras, Tabasco, 15 April, 1924 (C. H. Curran); one female, Prieta, Rep. Hond., 6 Apr., '24 (J. Bequaert); and one male, one female, Claremont, Jamaica, March 10, 1931 (E. L. Bell).

Type in United States National Museum.

Plecia (Rhinoplecia) rugosa Hardy

(Plate XXXVII, figs. 173a-c)

Plecia rugosa Hardy, 1940, Journ. Kan. Ent. Soc. 13, 25-27.

Following is the original description:

"This species seems to approach *rufimarginata* Hardy in general characters but is easily separated by the finely shagreened surface of the mesonotum, its slightly larger size and very different genitalia.

"*Male*.—*Head*: Rostrum produced about as long as antennae, folded beneath the face. Antennae nine segmented, the segments short and compressed. *Thorax*: Mesonotum shining, entire surface finely shagreened, somewhat more coarsely so on the lateral and anterior margins, more smooth posteriorly. Mesonotal furrows very distinct, terminating in a small depressed area just before the scutellum. Dorsum almost bare, a few scattered yellow hairs on the margin of the notum. Pleurae chiefly opaque, upper portions of sternopleurae also shagreened, with numerous long brown hairs; lower portions of sternopleurae shining and bare. Halteres black, stems yellow-brown. Legs and abdomen dark brown to black, covered with long black pile, tarsal joints slender. *Wings*: Uniformly yellow-

* The type localities were left out of the original description, so these are recorded here

brown fumose, stigma but little darker than membrane, veins brown. Fork of third vein, R_{2+3} (R_{3+4}), curved moderately into the costa; fork of media situated just before one-half the distance from r-m crossvein to the fork of the radial sector. Vein Cu_2 (Cu_1) scarcely sloped downward at its tip, anal cell as wide at apex as at middle.

"Genitalia: Ninth sternum broader than long, posterior lateral margins not developed; hind margin with two moderately developed erections having a U-shaped concavity between them; median portion developed into a somewhat membranous area which fits above the aedeagus. Harpagones with a somewhat beaklike point apically, on inner side (fig. 173a). Ninth tergum about as long as wide, narrowing somewhat on apical one-third, hind margin with a small indentation (fig. 173b); hind margin of tergum developed inwardly to form a broad plate before the anal region, as seen from lateral or end view; this plate terminates in two strongly sclerotized, inward projecting points (fig. 173c).

"Length: body, 3-3.3 mm.; wing, 3.5 mm.

"Female.—Differs from the male in having the thorax entirely rufous and abdominal sterna lightly tinged with yellowish and first two abdominal segments yellow.

"Length: body, 4.5 mm.; wing, 4.6 mm."

Type locality: Bet. Queremal and Buenaventura, Columbia.

Type in the American Museum Collection.

Plecia (Rhinoplecia) seminitens Edwards

(Plate XXXVII, figs. 174a-c)

Plecia seminitens Edwards, 1938, Ann. Mag. Nat. Hist. Ser. II, V. 2, 321-322.

The following is the original description of the male:

"Male. Black, only stem of halteres and base of femora brownish. Eyes bare, undivided and without any obviously differentiated lower area of smaller facets. Mouth-parts and clypeus folded back under head as usual in this subgenus, but not noticeably elongate; palpi shortish, each of the four segments very little longer than broad. Antennal flagellum short, 6-segmented, terminal segment the largest. Mesonotum with three brightly shining stripes; shoulders and front ends of a pair of narrow deep grooves between the stripes with coarse gray dusting; median stripe not obviously grooved down the middle; similar coarse gray dusting on most of pleurae, but lower half of sternopleurae shining black; a small patch of hair in middle of sternopleurae, pteropleura bare. Abdomen shining. Femora somewhat clubbed on distal half; hind tibiae slightly and uniformly

thickened. Wings with uniform dark smoky tint; R_4 short and vertical. Hypopygium: tergite pubescent, posterior margin nearly straight, in middle with a small bare shining black triangular process which is curved inwards; styles large and lateral in position, divided distally into two lobes, the upper lobe broad, flat and rounded, the lower small, narrow and thumb-like. Length of body or wing 4 mm."

The writer has studied a metatype male and makes the following addition to the description: Ninth sternum with a broad flat topped median process on hind margin; inner lobe of harpagones projecting at about level or slightly above the outer lobe from ventral view (fig. 174a), narrower and slightly longer than the thick outer lobe; harpagones broad from lateral view, with both lobes visible (fig. 174b), although the outer (stronger) lobe folds inward making it necessary to tilt the structure in order to view it. Median process of ninth tergum scarcely produced beyond posterior margin of the segment (fig. 174c), and flat topped in the specimen studied.

Doctor Edwards stated (in correspondence) that he felt quite sure the female described as *seminitens* belongs to a different species, however, it is possible that they are correctly associated as several dimorphic species have been found in this group, so the description is quoted here: "Female (?). Resembles the male in most respects, notably its small size, shining black lower half of sternopleura and almost uniformly dark wings, but differs as follows:—Mouth-parts even shorter. Antennal flagellum dark brownish, 8-segmented (apart from the nipple-like tip). Mesonotum wholly light reddish. R_4 more oblique. Length of body or wing 5 mm."

Type locality: Nova Teutonia, Brazil.

Type in the British Museum.

The writer has studied a topotype.

Plecia (Rhinoplecia) serrata Hardy

(Plate XXXVII, figs. 175a-c)

Plecia (Rhinoplecia) serrata Hardy, 1942, Can. Ento. LXXIV, 114.

"This species is related to *vittata* Wiedemann and *bicolor* Bellardi but separates from all other members of this genus by its unique genitalia.

"MALE.—Antennae nine segmented, the terminal segments small and nipplelike. Rostrum as long as the head, longer than the antennae. Pleurae brown to black with a faint rufous tinge. Dorsum entirely rufous, halteres black. Legs chiefly black, bases

of femora somewhat yellowish. Wings smoky fumose, vein R_{3+4} almost vertical, but slightly curved into the costa. Fork of veins M_1 and $_2$ situated at about the basal one-third of the distance from the radio-medial crossvein to the fork of the radial sector. Stigma concolorous with the membrane. *Genitalia*: Ninth sternum with a pair of pointed lobes on the posterior margin in the middle, posterior lateral margins of sternum not developed. Harpagones strong, very broad, with numerous small pointed teeth on the inner apical edges, as seen from the ventral view (fig. 175a), almost square topped from a lateral view (fig. 175b). Ninth tergum with a small concavity medianly on the hind margin (fig. 175c).

"Length: body, 4 mm.; wing, 4.7 mm.

"Female unknown."

Type locality: Villarica, Paraguay.

Type at Michigan State College.

Plecia (Rhinoplecia) similis Rondani

(Plate XXXV II, figs 176a-c)

Plecia similis Rondani, 1850, Nuovi Ann. Delle. Sci. Nat. Ser. III, tom II, 193

Plecia minor Jaennicke, 1867, Neue Exot. Dipt. Abhandl., d. Senckenb. Naturl. G. Bd. VI, 818.

The species at hand fits the original description better than any other Brazilian species and all of the specimens examined from the type locality have been the same. This is also the species which is considered *similis* in the British Museum.

Entirely black species. *Head*: Rostrum strongly produced, longer than the antennae in both sexes. Antennae nine segmented in the male, eleven segmented in the female, the latter more compacted. *Thorax*: Dorsum faintly shining with three longitudinal furrows down the middle, the median groove weak. Pleurae opaque, lower half of sternopleurae faintly shining, upper portion of sternopleurae with sparse pale hair. Wings subhyaline, basal and costal portion lightly fumose. Fork of third vein (R_{3+4}) curved into costa; fork of M_1 and $_2$ situated just before one-half the distance between the r-m crossvein and the fork of the radial sector. *Male genitalia*: Ninth sternum longer than wide with a well developed median process on the hind margin, this development is bifid apically. Harpagones broad and blunt, especially from a ventral view (fig. 176a). From a lateral view a blunt arm projects inward slightly on outer margin, from this view a large hollowed out area can be seen in the center (fig. 176b). Ninth tergum concave on posterior

margin with a somewhat membranous development at the center (fig. 176c).

Male length: body, 4.5-5 mm.; wing, 5-6 mm.

Female length: body, 5.5-6 mm.; wing, 7 mm.

Type locality: San Sebastian.

Type probably at the University of Bologna.

Specimens have been examined from S. Jose Cos. Campos., July, 1933 (H. S. Lopes); Brazil, S. Paulo Est. S. Paulo, July 9, 1928; Ctr. Brazil, Oct. 22, 1924 (Flacher); and Toinville, Brazil (Lichtwardt).

Plecia (Rhinoplecia) trilobata Hardy

(Plate XXXVII, figs. 177a-d)

Plecia (Rhinoplecia) trilobata Hardy, 1942, Can. Ento. LXXIV, 114-115.

"This species is near *bicolor* Bellardi but the male genitalia are so distinctive that its identity can not be mistaken. The antennae are distinctly yellowed in this species and the pleurae are somewhat tinged with rufescent. These characters alone, however, would not separate it conveniently.

"MALE.—Antennae nine segmented, counting knoblike tip. Rostrum produced slightly longer than the antennae. Compound eyes divided by a shallow furrow on lower one-third. Wings comparatively short, about equal to the length of body, vein R_{3+4} gently curved. Hind tarsi somewhat swollen, subsegments short. *Male genitalia*: Ninth sternum rather elongate compared with its width, its posterior margin undulated (fig. 177a). Harpagones three lobed, two arms visible from ventral view, the third only seen from lateral. Dorsal arms long and curved, median arms small with two apical points; ventral lobes large and rounding, the surface densely pitted (fig. 177b). Ninth tergum broad, with a small V-shaped concavity from a direct dorsal view (fig. 177c); the inner top edge of the segment is developed inward into a broad flat area and two sharp points (fig. 177d); this can only be seen by looking directly down into the genital chamber.

"Length: body, and wings, 4.7-5 mm.

"FEMALE.—Antennae eleven segmented; bases of femora somewhat yellowed; pleurae more rufous tinged, all tarsi slender.

"Length: body, 5.8 mm.; wing, 6.4 mm."

Type locality: British Guiana, Upper Courantyne R., King Frederick William IV Falls.

Type to be returned to the British Museum.

Plecia (Rhinoplectia) uberta Hardy

(Plate XXXVII, figs. 178a-e)

Plecia (Rhinoplectia) uberta Hardy, 1942, Can. Ento. LXXIV, 115.

"This species is related to *collaris* by having the anterior portion of the dorsum blackish, it is distinguished by its small, acutely pointed harpagones, small median development on the hind margin of the ninth sternum and the V-shaped cleft of the posterior margin of ninth tergum.

"**MALE.**—*Head*: Rostrum well developed, as long as the head and longer than the antennae. Antennae eight segmented, slightly yellowish tinged, most segments longer than wide and rather loosely joined. Compound eyes not divided by a transverse depression. *Thorax*: Mesonotum and scutellum chiefly rufous, anterior portion of dorsum black. Pleurae yellow-brown to blackish; humeral ridges largely yellow; halteres black, stems pale. All tarsi slender, posterior basitarsi not at all swollen, equal in length to the next four subsegments. *Wings*: Brownish yellow fumose, stigma slightly darker than the membrane. Anterior fork of Rs (R_{3+4}) straight and almost vertical. Cubital cell widely open in the wing margin. *Genitalia*: Ninth sternum with a blunt median projection on the posterior margin, lateral margins not developed. Harpagones small, slender and rather sharply pointed (fig. 178c), folded downward in normal position, scarcely visible from ventral view unless plate is tilted back (fig. 178a). Ninth tergum broader than long with a deep V-shaped concavity on posterior margin (fig. 178b).

"Length: body, 6-6.5 mm.; wing, 7.5-8 mm."

Type locality: Lombardia, Honduras.

Type in United States National Museum.

This species has also been reported from Motzorongo, V. C., Cordoba and Teapa, Tabasco, Mexico.

Plecia (Rhinoplectia) varabilis Hardy

(Plate XXXVIII, figs. 179a-c)

Plecia (Rhinoplectia) varabilis Hardy, 1942, Can. Ento. LXXIV, 115-116.

"This species can be separated from *rufithorax* Walker only by the male genitalia. It is easily distinguished by the characteristic development of the ninth sternum and the small V-shaped cleft on the hind margin.

"The rostrum is well developed, longer than the antennae and folded beneath the face in resting position, compound eyes without a transverse groove on lower portion. Antennae of male eight seg-

mented, of female ten segmented, antennae as well as pleurae and sides of abdomen often tinged with yellow. *Male genitalia*: Ninth sternum broad; posterior lateral margins strongly developed, reaching much beyond the bases of the harpagones. Hind margin of sternum with a characteristic knoblike development in the middle (fig. 179a). Harpagones well developed, with several irregular teeth or bumps apically (fig. 179b). Ninth tergum but little wider than long, hind margin with a small V-shaped excavation in the middle (fig. 179c).

"The specimens in the type series show considerable variation in color, the typical coloration being yellow-orange without maculations, varying from this to dark rufous with irregular dark spots. Some of the female specimens in the series conform with the latter but they appear to be slightly teneral and this is probably not characteristic.

"Length: body, 5-6.7 mm; wing, 5.3-8.6 mm."

Type locality: Barro Colorado, Canal Zone.

Type in American Museum of Natural History.

This species has been recorded from various localities in Panama and Guatemala.

Plecia (Rhinoplecia) vittata Wiedemann

(Plate XXXVIII, figs 180a-c)

Plecia vittata Wiedemann, 1828, Aus Zweifl. Ins I, 75.

The late Doctor Edwards of the British Museum compared specimens with the female type and sent the writer a male specimen from his series; this conformed with a Brazilian species in the writers collection.

This species is related to *bicolor* Bellardi and is best separated from that species by the male genitalia. The wings are clearer than in *bicolor*, the costal area is somewhat smoky near the apices of the wing in males; the legs seem more consistently black and the genitalia more shining, the specimens are also slightly larger.

Male genitalia: Ninth sternum broad and rounded, with a slight inward dip on hind margin. Harpagones very stout and irregular in shape (fig. 180a) somewhat pointed apically but inner margin developed into a large blunt projection, visible from a lateral view (fig. 180b). Hind margin of ninth tergum developed into two obtuse lobes, these fold back slightly toward the anal area. Ninth tergum wider than long (fig. 180c).

The female can be separated from *bicolor* only on size and geographical distribution.

Male length: body, 5-5.5 mm.; wing, 6 mm.

Female length: body, 6.5-7.5 mm.; wing, 8 mm.

Type locality: Brazil.

Type in Berliner Museum.

Specimens have been examined from Brazilien Nova Teutonia, 27° 11' B. 52° 23' L. 1938 (Fritz Plaumann); M. do Governo, Oct. 31 (J. Melzes) and Rio de Janeiro, Brazil, Oct. 1919 (Cornell Univ. Exped. Lot 569). Edwards also reports it from Santa Catharina, Brazil.

Plecia (Rhinoplectia) zenia Hardy

(Plate XXXVIII, figs. 181a-e)

Plecia (Rhinoplectia) zenia Hardy, 1942, Can. Ento. LXXIV, 109-110.

"This is related to *rufithorax* Walker but the male genitalia are very different; the fork of the radial sector (vein R_{3+4}) is somewhat more sharply curved at its middle (near fig. 161e) and the fork of the media arises just before the middle of the distance between the r-m crossvein and the fork of the R_s .

"*Male genitalia*: Posterior lateral margins of the ninth sternum strongly produced, extending almost as long as posterior median margin of sternum; the segment is gradually convex, with a small development in the middle on hind margin (fig. 181d). This is scarcely visible from a ventral view. Harpagones well developed and very irregular in shape, covered with numerous toothlike points and bumps (fig. 181c). Ninth tergum about as high as long, longest in middle, gently convex, with a narrow slitlike invagination medially on the posterior margin (fig. 181b).

"Male length: body, 4-5 mm.; wing, 4.5-6 mm.

"*Female genitalia*: Eighth sternum twice as wide as long with the posterior lateral margins more elongate than the rounded median lobes (fig. 181e). Ninth tergum about half as long on lateral margins as its width, deeply cleft on both anterior and posterior margins with only a narrow bridge of sclerite joining the lateral plates; lateral plates strongly produced anteriorly (fig. 181a).

"Female length: body 5-6 mm.; wing, 5.5-6 mm."

Type locality: Higuito San Mateo, Costa Rica.

Type in United States National Museum.

The species has also been recorded from San Jose, San Carlos, and Santa Ana, Costa Rica.

Plecia femorata Macquart, 1838, Dipt. Exot. Nouv. ou peu connus, Mem. de la Soc. Sci. Lille i, i, 90. Described from Brazil but cannot be placed.

Bibio Geoffroy*Bibio* Geoffroy, 1764, Hist. Ins. V. 2, 571.

The genus is characterized by the development of the tibial spurs and the presence of the radio-medial crossvein separating the third and fourth longitudinal veins (R_5 and M). The subcostal vein is usually well developed and extends to or near the costal margin. The first branch of radius consists of radial veins one to four inclusive fused together, while the posterior branch is interpreted as the fifth radial vein. The comparative length of the r-m crossvein with the length of the basal portion of vein R_5 (Rs) is a very important taxonomic character. The veins beyond radius (so-called posterior veins) are usually lighter in color and are often concolorous with the membrane. The costa ends at or but slightly beyond the end of vein R_5 . The antennae are rather short and composed of six to ten short, broad, closely pressed segments; each segment bearing one or two rows of strong hairs in addition to fine pubescence. The eyes of the male are contiguous on the front while those of the female are broadly separated. The femora and tibiae of the males are usually swollen, never long, and slender as in the more primitive genera. In many species the subsegments of the posterior tarsi are greatly dilated.

For the most part the genital structures of the male *Bibio* are not as important taxonomically as in other genera and in many groups the specific characters of the genitalia are very obscure and difficult to differentiate; in some cases no noticeable specific differences appear to be present.

Genotype: *Tipula hortulana* Linn., 1762, Hist. Abregee Ins. Vol. 2, p. 568.

KEY TO SPECIES OF MALE BIBIO

1. Inner spur of front tibiae short, not more than one-half the length of outer..... 2
Inner spur of front tibiae long, conspicuously more than one-half the length of outer, 9
2. Crossvein r-m one-third to one-fourth the length of basal part of Rs 3
Crossvein r-m at least one-half the length of the basal part of Rs 22
3. Legs entirely black or dark brownish red, never rufous..... 4
At least the tibiae in part yellow; posterior basitarsi scarcely over two times as long as wide 6
4. Posterior basitarsi one-third to one-fourth as wide as long; hind femora averaging 2 mm., hind tibiae 1.8 mm.; smaller species, length of wing 4.5-6.5 mm. 5
Posterior basitarsi five to six times as long as wide; hind femora averaging from 2.5-2.9 mm.; hind tibiae 2.4-2.6 mm.; usually larger species, length of wing 6-9 mm. 7
5. Wings dusky to smoky hyaline..... 5a *melanopilus* Hardy, p. 473
Wings hyaline to yellowish fumose; pile of dorsum yellow.
albipennis var. *tenuipes* Coquillett, p. 453
- 5a. Pile of thorax and legs chiefly black; humeral ridges tinged with yellow. Wing 5-6 mm. *melanopilus melanopilus* Hardy, p. 473

- Pile of thorax, coxae and femora yellow; humeral ridges black; slightly larger species. Wing 6-6.5 mm. *melanopilosus* var. *biscriptus* Hardy, p. 478
6. Femora black, thorax and abdomen mostly black pilose. *curtipes* James, p. 462
Femora more rufous, abdomen at most gray pilose, thorax with some yellow pile.
..... *kansensis* James, p. 469
7. Wings dusky *albipennis* *beameri* n. sub. sp., p. 451
Wings hyaline 8
8. Sclerites of abdomen not overlapping, comparatively short, revealing white or gray conjunctiva *conjunctivus* Hardy, p. 460
Sclerites overlapping, conjunctiva black. 8a *albipennis* Say, p. 451
8a. Pile usually longer and more abundant, especially on males (western).
..... *albipennis* *hirtus* Loew, p. 452
Pile shorter and less abundant (eastern). *albipennis* *albipennis* Say, p. 451
9. Legs black or dark reddish brown. 10
Legs rufous or bicolored. 13
10. Pile of thorax black. 11
Pile of thorax yellow, or with some yellow pile intermixed. 12
11. Crossvein r-in one-fourth the length of Rs. *necrotus* Hardy, p. 476
Crossvein r-in equal to the length of Rs. *criorhinus* Bellardi, p. 462
12. Posterior veins concolorous with membrane; inner spurs of front tibiae nearly equal to the outer *mickeli* Hardy, p. 474
Posterior veins dark; inner spurs of front tibiae shorter, about three-fourths the length of the outer *utahensis* Hardy, p. 489
13. Only femora rufous *femoratus* Wiedemann, p. 463
More of legs yellow to rufous 14
14. Larger species, (wing 7.5-9.5 mm.); pile chiefly dark. 15
Smaller species (wing 4-6 mm.); pile usually pale. 17
15. Femora (at least basally) dark brown to black, contrasting in color from posterior tibiae; pile gray to black. *nervosus* Loew, p. 477
Femora rufous, dark tipped, concolorous with posterior tibiae. 16
16. Wings chiefly hyaline, posterior basitarsi not enlarged. *xanthopus* Wiedemann, p. 491
Wings yellowish fumose, posterior basitarsi enlarged. *velorum* McAtee, p. 490
17. Subsegments of hind tarsi long and slender, metatarsi about seven times as long as wide and about three times as long as inner spurs of hind tibiae (fig. 191a). Posterior veins concolorous with the membrane; dorsum of female rufous. Posterior femora average 2.6 mm. in length, posterior tibiae 2.4 mm. *fraternus* Loew, p. 465
Subsegments of hind tarsi rather short and thick, metatarsi from two and one-half to four and one-half times as long as wide, scarcely over twice as long as tibial spurs. Posterior veins darker than membrane in most species; dorsum of female black. Posterior femora average 1.7-2 mm. in length, tibiae 1.5-1.7 mm. 18
18. Posterior veins concolorous with the membrane. 19
Posterior veins darker than the membrane. 20
19. Pile of thorax and abdomen chiefly black. *nigripilus* Loew, p. 480
Pile chiefly yellow *abbreviatus* Loew, p. 450
20. Pile chiefly yellow, legs almost entirely rufous or yellow. 21
Pile black, legs chiefly reddish brown to black. *velcidus* Hardy, p. 490
21. Eyes divided into an upper and lower portion by a transverse depressed area just below middle line; wings hyaline or slightly yellow fumose; spurs of posterior tibiae thick and blunt at apex, hind metatarsus not quite three times as long as wide (fig. 188a) *carri* Curran, p. 458
Transverse depression near lower one-fourth of compound eye; wings dusky to smoky; spurs of posterior tibiae more slender and acute, metatarsus four times as long as wide (fig. 195a). (Some atypical specimens will run here).
..... *Knowltoni* var. *pallidus* Hardy, p. 470
22. Posterior basitarsi distinctly enlarged, almost to equally as large as the end of the femora 23
Posterior basitarsi not distinctly swollen 40
23. Legs brown to black, not distinctly bicolored. 24
Legs distinctly bicolored or entirely yellow to rufous. 27
24. Thorax and legs entirely dark haired. *slossonae* Cockerell, p. 186
Thorax and legs pale haired, sometimes with a few scattered black hairs on the dorsum 25 ✓

25. Larger species, wing 8.6-9.3 mm.; wings brownish fumose. *rufithorax* Wiedemann, p. 488
 Smaller species, wing 4.5-5.5 mm.; wings pale yellow fumose..... 26
26. Stigma dark brown, posterior veins darker than membrane. Posterior basitarsus about three times as long as wide (fig. 196b); all tibial spurs acute; outer spur of front tibiae extending about one-third the length of the basitarsus (fig. 190a),
longipes Loew, p. 472
 Stigma light yellow, posterior veins concolorous with the membrane. Hind basitarsus scarcely over twice as long as wide (fig. 202b); tibial spurs more blunt; outer spur of front tibia half as long as the basitarsus (fig. 202a)..... *sericatus* Hardy, p. 484
27. Femora entirely black or very dark; basal constriction never yellow. Stigma obsolete 28
 Femora bicolored or entirely rufous..... 29
28. Pile of thorax black. Wings slightly yellowish hyaline..... *monsteri* James, p. 475
 Pile of thorax yellow. Wings hyaline..... *labradorensis* Johnson, p. 471
29. Femora chiefly rufous, not more than apices dark..... 33
 Basal constriction of femora yellow, otherwise black or dark reddish brown..... 30
30. Pile black *bryanti* var. *nigrita* Curran, p. 457
 Pile pale or yellow 31
31. Posterior basitarsi strongly swollen, rather globular, only two and one-half times as long as wide and broader than apices of femora; tibiae strongly dilated; posterior veins darker than membrane *fluksi* Hardy, p. 464
 Posterior basitarsi not greatly dilated, more cylindrical, at least three and one-half times as long as wide; posterior veins concolorous with membrane..... 32
32. Wings whitish or grayish hyaline; femora black apically..... *pingreensis* James, p. 481
 Wings dark yellow fumose; apex of femora brown..... *tenellus* Hardy, p. 486
38. Femora entirely yellow to rufous, not tipped..... 38
 At least apices of femora narrowly black tipped..... 34
34. Pile black; femora only slightly tipped; wings hyaline..... *bryanti* Johnson, p. 456
 At least some yellow pile on dorsum, that of pleurae, coxae and femora always pale, 35
35. Smaller species (wing 4-5 mm.); wings yellowish hyaline, posterior veins darker than membrane *fliginatus* Hardy, p. 464
 Larger species (wing 7-8.5 mm.); wings yellowish fumose..... 36
36. At least posterior tibiae concolorous with femora, not with a dark brown to black stripe running the entire length; posterior veins concolorous with membrane..... 37
 Anterior tibiae dark reddish brown to black, middle tibiae dark reddish to brown, posterior tibiae with dark brown to black strip running the entire length dorsally. Posterior veins yellow-brown *columbiaensis* Hardy, p. 459
37. Tibiae, hind femora and basal tarsal joints pale, with dark tips. *inaequalis* Loew, p. 468
 Only femora dark tipped *fumipennis* Walker, p. 466
38. Larger species, wing 6.5-8.5 mm.; genitalia black..... 39
 Smaller species, wing 4.5 mm.; ninth sternum bright yellow, coxae and trochanters yellow *townesi* n. sp., p. 487
39. Pile of thorax black; wings hyaline *bryanti* Johnson, p. 456
 Pile of thorax yellow; wings brownish yellow fumose..... *inaequalis* Loew, p. 468
40. Legs distinctly bicolored or rufous, at least bases of tibiae light colored..... 42
 Legs entirely dark 41
41. Legs shining black; wings dark yellow-brown fumose..... *carolinus* Hardy, p. 457
 Legs dark reddish brown to black; wings whitish hyaline *similis* James, p. 485
42. Only femora rufous *holti* McAtee, p. 467
 More of legs yellow to rufous..... 43
43. Femora dark brown to black contrasting from paler tibiae, at least bases of tibiae yellow to rufous 44
 Femora rufous, not thus contrasting, usually entirely rufous, if darkened apically the tibiae are also darkened 48
44. Larger species, wing 7-8.5 mm..... 45
 Smaller species, wing 4-5.5 mm. 47
45. Wings hyaline 46
 Wings yellow-brown fumose; sometimes only bases of tibiae yellow rufous, pile dense, yellow. Humeral crossvein obsolete *45a neojacobi* n. n., p. 476
45a. Only the bases of tibiae yellowish to rufous, legs otherwise black.
neojacobi neojacobi n. n., p. 476
 Tibiae, first two tarsal subsegments and bases of femora rufous.
neojacobi rufitibialis Hardy, p. 477

46. Posterior veins concolorous with the membrane; pile dense black. *vestitus* Walker, p. 491
Posterior veins darker than membrane; pile yellow. *atripilosus* James, p. 455
47. Pile of dorsum long, dense black with yellow hairs intermixed, or pile of dorsum entirely yellow; wings hyaline to dusky. Inner spurs of front tibiae about one-fourth the length of the outer 47a *nigrifemoratus* Hardy, p. 478
Pile very sparse and short, chiefly black; wings yellow fumose. Inner spurs of front tibiae about one-half the length of outer. *cognatus* Hardy, p. 459
47a. Pile of dorsum chiefly black. *nigrifemoratus nigrifemoratus* Hardy, p. 478
Pile of dorsum entirely yellow. *nigrifemoratus* var. *gibvus* Hardy, p. 479
48. Larger species (wing 6-9.5 mm.); posterior basitarsi as long as next two subsegments and five times as long as wide. 51
Smaller species (wing 4-5 mm.); posterior basitarsi shorter than next two subsegments and less than four times as long as wide. 49
49. Middle and anterior legs marked with brown, anterior tibiae black basally; dorsum of female black 49a *knowltoni* Hardy, p. 469
Middle and anterior legs concolorous with posterior legs; dorsum of female slightly rufous 50
49a. Wings yellowish *knowltoni knowltoni* Hardy, p. 469
Wings dusky *knowltoni* var. *pallidus* Hardy, p. 470
50. Tibiae with gray to black pile contrasting with silky yellowish pile of femora; eyes mostly pale pilose *alexanderi* James, p. 453
Tibiae with softer yellow pile; eyes black pilose. *painteri* James, p. 480
51. Crossvein r-m only one-half the length of the basal part of Rs; posterior veins entirely obsolete; tarsal joints very slightly swollen, not nearly as broad as end of femora; pile of dorsum dark yellow-brown; femora and tibiae dark on apical portion *conus* Hardy, p. 461
Crossvein r-m over one-half, usually equal to base of Rs; tarsal joints slender. 52
52. Pile of dorsum black *tristis* Williston, p. 488
Pile of dorsum chiefly yellow 53
53. Wings chiefly hyaline to dusky; tibiae and tarsi of front two pairs of legs darker than femora, which are light reddish yellow; posterior legs entirely reddish yellow, joints darker *alienus* McAtee, p. 454
Wings slightly yellow fumose, tibiae and tarsi, of at least posterior legs, concolorous with femora 54
54. Thorax and abdomen entirely black. Posterior veins darker than the membrane. 54a *xanthopus* Wiedemann, p. 491
Posterior margin of thorax, parts of pleurae, coxae and abdomen with dark reddish coloration. Posterior veins concolorous with membrane. *rufalipes* Hardy, p. 482
54a. Pile pale, less abundant; wings yellowish fumose; pleurae of female often in part yellow to rufous *xanthopus xanthopus* Wiedemann, p. 491
Pile more abundant, gray to black; wings somewhat smoky; pleurae of female black (western) *xanthopus palliatus* McAtee, p. 492

KEY TO THE SPECIES OF FEMALE *Bibio*

1. Inner spurs of front tibiae short, not more than one-half the length of the outer. . . 2
- Inner spurs conspicuously more than one-half the length of the outer. 8
2. Crossvein r-m at least one-half the length of the basal section of the radial-sector, 16
- Crossvein r-m short, not more than one-third the length of the basal section of the radial-sector 3
3. Legs entirely black, or dark brownish red, never rufous. 4
- Legs chiefly rufous, posterior basitarsi just one and one half-times as long as second tarsal subsegment 6
4. Posterior basitarsi scarcely over three times as long as wide; smaller species (wing 4-6 mm.) 5
- Posterior basitarsi almost six times as long as wide; usually large species (wing 5.5-9.5 mm.) 7
5. Wings dusky to smoky hyaline 5a *melanopilosus* Hardy, p. 478
- Wings hyaline to yellowish; pile of dorsum yellow. *albipennis* var. *tenuipes* Coquillett
- 5a. Pile of thorax, coxae and femora chiefly black, humeral ridge tinged with yellow; legs somewhat rufous. *melanopilosus melanopilosus* Hardy, p. 478
- Pile of thorax, coxae and femora pale, humeral ridge black; legs entirely black; slightly larger species, length of wing 6-6.5 mm, *melanopilosus bieptus* Hardy, p. 474

- | | | |
|-----|---|---|
| 6. | Thorax and abdomen chiefly black pilose; inner spurs of front tibiae about one-half the length of the outer | <i>curtipes</i> James, p. 462 |
| | Thorax and abdomen with grayish yellow pile; inner spurs not more than one-fourth the length of the outer | <i>kansensis</i> James, p. 469 |
| 7. | Humeri each with large conspicuous red spot in addition to the yellow of humeral ridges; pleurae with rufous markings. Wings smoky | <i>conjunctivus</i> Hardy, p. 460 |
| | Thorax entirely black, except for pale humeral ridges. 7a | <i>albipennis</i> Say, p. 451 |
| | 7a. Wings hyaline | 7b |
| | Wings dusky | <i>albipennis beameri</i> n. sub. sp., p. 451 |
| | 7b. Pile usually longer and more abundant, especially on males (western).
<i>albipennis hirtus</i> Loew, p. 452 | |
| | Pile shorter and less abundant (eastern) | <i>albipennis albipennis</i> Say, p. 451 |
| 8. | Femora lighter in color than tibiae and tarsi, dorsum of thorax black. | 9 |
| | Femora not thus contrasting, if tibiae are of darker color, the dorsum is rufous. | 11 |
| 9. | Tibiae and tarsi dark reddish brown; wings yellow fumose; all leg joints dark tipped | <i>velorum</i> McAtee, p. 490 |
| | Tibiae and tarsi black, only tibial spurs rufous. Wings blackish. | 10 |
| 10. | Coxae and trochanters rufous, anterior pair lighter. | <i>mickeli</i> Hardy, p. 474 |
| | Coxae and trochanter entirely black. | <i>femoratus</i> Wiedemann, p. 463 |
| 11. | Wings smoky, blackish costally. | <i>basalis</i> Loew, p. 456 |
| | Wings slightly yellowish hyaline to yellow-brown. | 12 |
| 12. | Wings only slightly yellowish hyaline; inner tibial spur but slightly over one-half the length of outer | 13 |
| | Wings yellow-brown; inner tibial spurs always conspicuously over one-half the length of outer | 14 |
| 13. | Smaller species, wing 4.5 mm. in length; leg joints somewhat shortened giving the legs a drawn up appearance; inner spurs of front tibiae but slightly over one-half the length of the outer | <i>carri</i> Curran, p. 458 |
| | Larger species, wing 7-8 mm.; leg joints not shortened, 13a | <i>xanthopus</i> Wiedemann, p. 491 |
| | 13a. Pleurae wholly dark. | <i>xanthopus palliatus</i> McAtee, p. 492 |
| | Pleurae in part yellow to rufous. | <i>xanthopus xanthopus</i> Wiedemann, p. 491 |
| 14. | Smaller species, wing 4.5-6.5 mm. | 15 |
| | Larger species, wing 7.5-9.5 mm. | <i>neruosus</i> Loew, p. 477 |
| 15. | Hind metatarsi six to seven times as long as wide, tibial spurs extend about one-third the length of metatarsi; thorax chiefly rufous, sometimes with only a slight tinge of red on the dorsum | <i>fraternus</i> Loew, p. 465 |
| | Hind metatarsi not more than three to four times as long as wide, spurs of hind tibiae extending almost half the length of metatarsi; thorax black,
<i>abbreviatus</i> Loew, p. 450 | |
| 16. | At least the mesonotum chiefly rufous. | 17 |
| | Top of thorax chiefly or entirely black, never with more than anterior margins of humeral ridges pale | 26 |
| 17. | Dorsum of thorax or the pleurae with dark brown to black markings; thorax never entirely rufous | 18 |
| | Entire thorax rufous | 22 |
| 18. | Legs dark brown to black; larger species. | 19 |
| | Legs rufous to yellowish | 20 |
| 19. | Length of head behind the eyes much shorter than length of the eyes (fig. 201b); face not tuberculate in middle; head and prothorax finely shagreened; scutellum shining black | <i>rufithorax</i> Wiedemann, p. 493 |
| | Length of head behind eyes longer than length of eyes (fig. 187a); face tuberculate in the middle; head and prothorax brightly polished and smooth; scutellum rufous.
<i>carolinus</i> n. n., p. 457 | |
| 20. | Larger species, wing 8-9 mm. Wings dark yellow fumose. | <i>fumipennis</i> Walker, p. 466 |
| | Smaller species, wing 5-7 mm. Wings chiefly hyaline or but lightly yellow fumose, 21 | |
| 21. | Dorsum of thorax entirely reddish yellow; posterior tibiae not noticeably clavate,
<i>alexanderi</i> James, p. 453 | |
| | Dorsum of thorax with black markings; posterior tibiae clavate. | <i>painteri</i> James, p. 480 |
| 22. | Abdomen as well as thorax and legs chiefly reddish or testaceous, with only minor dark markings | 23 |
| | Abdomen black | 25 |

23. Tibiae and tarsi brownish red, darker in color from yellowish red femora.
rufalipes Hardy, p. 482
- Tibiae and tarsi yellow to rufous, not darker than femora..... 24
24. Larger species, wing 7-8.5 mm., wings yellowish in both sexes.....*inaequalis* Loew, p. 468
- Smaller species, wing 5-6 mm., wings of female smoky yellow fumose, of male hyaline.....*townesi* Hardy, p. 487
25. Hind coxae blackish, wings dusky fumose.....*alienus* McAtee, p. 454
- Hind coxae rufous, wings yellowish fumose.....*longipes* Loew, p. 472
26. Entire anterior margin of mesonotum pale; pleurae and abdomen in part reddish; legs including coxae and trochanters bright yellow.....*lobatus* Hardy, p. 471
- Only humeral ridges pale..... 27
27. Only femora rufous.....*holtii* McAtee, p. 467
- More of legs yellow to rufous..... 28
28. Smaller species, wing 5-7 mm. (only *monstri* and *flupei* from 6-7 mm.)..... 29
- Larger species, wing 7.5-9 mm..... 36
29. Wings dusky hyaline to smoky gray fumose..... 30
- Wings hyaline to yellow fumose..... 31
30. Coxae and trochanters black, femora of male black.....*nigrifemoratus* Hardy, p. 478
- Coxae and trochanters rufous, femora of male rufous.....*knowltoni pallidus* Hardy, p. 470
31. Coxae and trochanters rufous; pleurae usually with rufous markings. Posterior veins darker than the membrane..... 33
- Coxae, trochanters and pleurae black or tinged with dark reddish brown..... 32
32. Posterior veins concolorous with the membrane, coxae and trochanters black..... 34
- Posterior veins darker than the membrane, coxae and trochanters tinged with dark reddish brown (atypical specimens of this species will key out here).....*carri* Curran, p. 458
33. Wings dark yellow fumose, legs rather slender, the joints more elongate; crossvein r-m slightly longer than basal part of the Rs; posterior basitarsi of male swollen.
alsonae Cockerell, p. 486
- Wings hyaline to slightly yellow fumose; legs more robust; crossvein r-m slightly shorter than basal part of Rs; posterior basitarsi of male not swollen.
knowltoni knowltoni Hardy, p. 469
34. All femora brownish yellow, much darker in color than tibiae; posterior veins pale brown, darker than the membrane.....*flupei* Hardy, p. 461
- Femora yellow to rufous, not darker than tibiae; posterior veins concolorous with the membrane..... 35
35. Tibiae and tarsi broadly black tipped, last four tarsal subsegments chiefly black. Larger than succeeding species; wing 6-7 mm.....*monstri* James, p. 475
- Leg joints chiefly rufous, not extensively tipped, smaller species, wing 4.5-5.5 mm.
sericatus Hardy, p. 484
36. Wings yellowish fumose..... 37
- Wings dusky hyaline.....*xanthopus palliatus* McAtee, p. 492
37. Crossvein r-m about one-half the length of the Rs; wing 7-7.5 mm.; posterior veins concolorous with membrane; legs chiefly yellow; posterior tarsal subsegments of male slightly swollen.....*conus* Hardy, p. 461
- Crossvein over one-half, usually equal to Rs; wing usually 8-9 mm..... 38
38. Posterior veins darker than membrane; posterior basitarsi of male not swollen.
 38a *xanthopus* Wiedemann, p. 491
- Posterior veins concolorous with the membrane; posterior basitarsi of male strongly swollen.....*bryanti* Johnson, p. 456
- 38a. Pleurae of female wholly dark; male with the hair more copious and longer, usually darker sometimes wholly black (western), *xanthopus palliatus* McAtee, p. 492
- Pleurae of female often in part yellow to rufous; male with less abundant and shorter hair, usually pale on thorax and abdomen.
xanthopus xanthopus Wiedemann, p. 491

Bibio abbreviatus Loew

(Plate XXXVIII, figs. 182a-c)

Bibio abbreviatus Loew, 1864, *Diptera Americae Septentrionalis indigena*, Centuria, 5, No. 9, Compl. Work, p. 217.

Bibio abbreviatus Van der Wulp, 1881, *Tijds. V. Ent.* 24, 145. This is a homonym.

This species is related to *fraternus* Loew and is distinguished by the shorter and thicker tarsal subsegments of the male and the black dorsum of the female.

MALE.—Head and appendages, body (except pale humeral ridges) and coxae black, the pile of the head black, that of the body and legs pale; femora and succeeding leg joints, excepting front tibiae and the last two or three tarsal joints, yellow to rufous with dark tips, the anterior tibiae and last two to three tarsal subsegments dark brown to black. *Leg.*: Spurs of anterior tibiae rufous, the inner spurs almost equal to the outer in length. Subsegments of hind tarsi comparatively short and thick, the metatarsi are about two and one-third times as long as the inner spurs of posterior tibiae (fig. 182b). *Wings.*: Hyaline, anterior veins and stigma brown, posterior veins concolorous with membrane, radio-medial crossvein equal to the basal part of the posterior branch of radius. *Genitalia.*: Ninth tergum deeply V-shaped on hind margin, the cleft extending over half the length of the segment (fig. 182c). Ninth sternum broad, cleft about one-third the length of the segment on hind margin. Claspers rather narrow (fig. 182a).

FEMALE.—Females differ in having pale yellow fumose wings; posterior veins yellowed, slightly darker than the membrane. Coxae and trochanters yellow to rufous; the pleurae sometimes having yellowish markings. The hair of the female is more sparse and the hind metatarsi are slightly more slender.

Length of wing, 4-6 mm.

Type locality: District of Columbia.

Type in Cambridge Museum of Comparative Zoölogy.

This species is rather wide spread. Specimens have been studied from the following states and Canadian provinces: Ohio, South Dakota, Michigan, Kansas, North Carolina, New York, Maryland, Missouri, Virginia, Iowa, Georgia, Quebec and Ontario. Also type locality.

Bibio articulatus Say, *B. pallipes* Say or *B. baltimoricus* Macquart might be the same as this species, or one or more of them the same as *fraternus* Loew. None of these descriptions refers to the character of the tarsal subsegments so they cannot be separated. Specimens determined as *B. pallipes* Say, in various collections studied have

proved to be the same as *abbreviatus*, but Say's type is apparently lost and the determinations must be questioned.

Bibio albipennis Say

(Plate XXXVIII, fig. 183a)

Bibio albipennis Say, 1823, Desc. Dipt. U. S., Journ. Acad. Nat. Sci. Phila., vol. 3; 78; 1859 Compl. Writings, vol. 2 p. 69.

MALE.—Entirely shining black, except for pale humeral ridges. *Legs:* Inner spurs of front tibiae short, approximately one third of the length of the outer. Spurs of hind tibiae thick and blunt, inner spur extending about one third the length of the metatarsus (fig. 183a). Posterior metatarsi not swollen and about twice the length of the second joint, metatarsi about six times as long as wide. Hind femora average 2.9 mm. in length, hind tibiae 2.6 mm. Legs sometimes verging into brownish black but more consistently shining black. Pile of eyes dark brown to black, long and copious, that of the face gray; body, coxae and femora with pale yellowish to gray hair; tibiae and tarsi with short dark hair. *Wings:* Whitish hyaline; stigma and anterior veins dark brown, posterior veins lighter brown, darker than the membrane; radio-medial crossvein about one fourth the length of the basal part of the posterior branch of radius.

FEMALE.—The female differs in usually having reddish brown markings on the pleurae (sometimes entire body tinged), and the pile much more sparse and shorter.

Length of wing, 7-9.5 mm.

Type locality: Pennsylvania.

Type probably lost.

The type form seems to range east of the Rocky Mountains; the species is the most common of the Nearctic Bibionidae.

Bibio albipennis beameri n. sub. sp.

(Plate XXXVIII, figs. 184a-b)

This has been considered the same as *afer* McAtee⁴⁴ (nec Loew). It fits the description as being related to *albipennis* but differs in having the wings dusky fumose. Examination of the type of *afer* proved that these are not related. That the specimen described as *afer* McAtee is actually related to *Bibio rufithorax* Wiedemann.

In working with this form the writer has often debated its possible rank. In Kansas and the middle west it appears to be a distinct species but as there is such a great amount of variation over large series of *albipennis* Say and it is not uncommon to find dusky winged

44. 1923, Proc. Ent. Soc. Wash. Vol. 25, No. 3, 63.

variants, it is perhaps better to include this character in the specific concept.

The subspecies differs from typical *albipennis* in having the wings darker fumose and being smaller in size; the posterior median margin of the ninth sternum in the male is also more pronounced. The specimens are more sparsely pilose than *albipennis*, markedly more so than the subspecies *hirtus* Loew; wings yellow-brown to smoky fumose instead of milky white as in the typical form. The type series, from Kansas, are all of smaller size than *albipennis*; variants have been examined from other localities which verge into this subspecies. The females have a tinge of dull red on the legs, pleurae and abdomen; the hind portions of the humeri are dull red and the wings more brownish fumose.

Male genitalia: Ninth sternum broader than long with a pronounced gibbosity in the middle on hind margin; harpagones rather slender and curved (fig. 184a). Ninth tergum deeply cleft, with a small membranous portion in the bottom of the cleft (fig. 184b).

Length of male: body and wings 6 mm.

Length of female: body and wings 6.7 mm.

Holotype male, allotype female and one hundred and thirty-eight paratypes, one hundred and five males, thirty-three females, Douglas County, Kansas, May 11, 1931 (R. H. Beamer). All are in the Snow Entomological Collection.

Bibio albipennis hirtus Loew.

Bibio hirtus Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 2, 1864, compl. work, p. 213.

Similar to *albipennis*, the only distinction being the more copious and longer hair, especially in the males. In some cases the hair is much darker. The legs of the males are usually never tinged with brownish red; the females are usually entirely shining black. The anterior veins of the wing in both sexes are usually black and the posterior veins gray.

There is no sharp distinction between these two subspecies and in various localities they may intergrade. Generally *hirtus* seems to be confined to the western portion of North America and *albipennis* to the eastern.

Type locality: California.

Type in Cambridge Museum of Comparative Zoölogy.

Bibio albipennis var. *tenuipes* Coquillett

(Plate XXXVIII, fig. 185a)

Bibio tenuipes Coquillett, 1902, Proc. U. S. Nat. Mus., V. 25, p. 95. New combination.

This is apparently just a variety of *albipennis*. The only essential difference is its smaller size. This varies a great deal and so many intergrading forms appear in any large series of *albipennis* that no specific boundary can be set up. The *tenuipes* variety does not appear to be restricted in geographical distribution so can hardly be subspecific.

MALE.—Chiefly shining black, except for yellow humeral ridges and rufous tibial spurs. Pile of the eyes black, that of the under side of the head gray; thorax, abdomen, trochanters and femora with pale yellow to gray pile, that of tibiae and tarsi chiefly black. Legs rather shortened and appearing somewhat drawn up. Inner spurs of front tibiae very short, about one fourth the length of the outer (fig. 185a); hind femora clavate, tibiae only slightly so, outer edges almost straight; posterior basitarsi not enlarged and comparatively short, about one and one-half as long as the next segment. Wings hyaline, tinged with yellow in the costal cell and with gray in the marginal and basal cells; anterior veins and stigma dark brown, posteriors lighter.

FEMALE.—The female differs in having all pile short, pale yellow and legs tinged rather extensively with rufous; front femora strongly swollen and the wings more yellow fumose.

Type locality: Arizona.

Type in the United States National Museum.

The writer has identified the variety from Texas, Utah, Washington and Wisconsin. McAtee reports it from Colorado and New Mexico.

Bibio alexanderi James

Bibio alexanderi James, 1936, Some New Western Bibionidae, Amer. Mus. Nov. No. 382, p. 1-2.

This species is related to *fraternus* Loew and to *painteri* James, the shorter inner spurs of front tibiae will distinguish it from the first species and the more slender posterior tibiae and the short, sparse yellow pile of the eyes will separate it from the latter.

MALE.—Head and appendages, body (excepting the pale humeral ridges), coxae and trochanters black. Pile of eyes rather short and chiefly yellowish, that of remainder of head pale yellow to gray, with some black pile on the lower part of the occiput; pile of body and

legs chiefly yellow, quite dense and long. *Legs*: Femora, tibiae and first one or two joints of tarsi yellow-rufous, very slightly darkened at the end of the joints; remainder of tarsi dark brown to black. Inner spurs of the front tibiae not quite one-half the length of the outer; posterior basitarsi not enlarged, about twice the length of the second segment. *Wings*: Slightly dusky-fumose, clouding somewhat deeper along the costal margin; veins and stigma brown, posterior veins but little lighter than the anteriors; radio-medial crossvein equal to the basal part of posterior branch of radius, basal section of M_2 faint.

FEMALE.—The females differ sharply from the males in that the entire dorsum of the thorax (excepting dark brown to black pronotum), coxae and trochanters are yellow to rufous and the pleurae are quite extensively rufous with black markings. Pile more sparse.

Length of wing, 6 mm.

Type locality: Boulder Creek Bottoms, near Valmont, Colorado.

Type in American Museum of Natural History.

The author has identified specimens from Stillwater, Oklahoma, March, 1936 (A. E. Prichard).

Bibio alienus McAtee

Bibio alienus McAtee, 1923, Descriptions of *Bibio* from the Carolinas. Proc. Ent. Soc. Wash., Vol. 25, No. 3, 62-63

The writer having not definitely identified this species prefers to give McAtee's original description.

"Male.—Head and body black, the humeral ridges yellowish; short, erect hair upon eyes black; longer, flexuous hair of occiput dark, of thorax and abdomen whitish. The legs have the coxae, trochanters, tibiae and tarsi of first two pairs brownish to blackish, all femora reddish-yellow, hind legs of this color throughout, the joints more or less blackish distally. Wings nearly hyaline, a little fumose along costa, the stigma moderate in size, dark brown. Length of wing: 5-5.5 mm.

"Female.—Head black, abdomen brownish-black, thorax and most of legs reddish-yellow, front tibiae, hind coxae and tips of other leg joints blackish; hair of head, thorax and legs rather bristly, that of abdomen somewhat softer, pale reddish. Wings dusky fumose, darker costally, the stigma and veins near costa blackish. Length of wing: 7 mm."

McAtee states that the male of this species is close to *nervosus* Loew but that the pile of the occiput, eyes and thorax is longer and

more copious, and the wings are darker. From his description they would seem to differ by the posterior tibiae and tarsi contrasting in color from those of the anterior legs.

The female seems to be near *longipes* Loew but differs in that the hind coxae are blackish, and the wings more dusky.

Type locality: Raleigh, North Carolina.

Type in United States National Museum.

Bibio atripilosus James

(Plate XXXVIII, figs. 186a-b)

Bibio atripilosus James, 1936, Amer. Mus. Nov. No. 832, 2.

Near *vestitus* Walker but differing in that the pile of the thorax, abdomen and legs is dense, pale yellow and the femora are mostly black, slightly reddish apically.

MALE.—Head and appendages, body (humeral ridges yellowish), and trochanters black. Pile of eyes, upper part of face and occiput copious black; that of the under part of the face long, dense, yellow-gray; that of the body, coxae and femora whitish to yellow-gray; first two to three segments of the abdomen with dense patches of gray pile on lateral margins. *Legs*: Femora chiefly black, rufous apically; front femora each with a rufous stripe running longitudinally, bordered by black above and below. Tibiae rufous with brownish markings medially and apically. Inner spurs of front tibiae short, about one-third the length of the outer. Basitarsi about twice as long as the succeeding joint, first two basal joints of tarsi yellowish-black at apices, next three subsegments verging into black. *Wings*: Hyaline, anterior veins and stigma dark brown, posterior veins light brownish yellow; crossvein r-m equal in length to the basal part of Rs. *Genitalia*: Cleft of ninth sternum very shallow and broad, distinctly shaped, the inner margins being indented giving a steplike appearance; the sternum is produced into an acute point on each inner margin at base of harpagones. Harpagones broad medially, each with a long apical point and a short tooth developed on the inner edge (fig. 186a). Ninth tergum gently concave on posterior margin, segment about twice as wide as long on median line. Cerci strongly developed and quite heavily sclerotized (fig. 186b). Pile of genitalia long and yellow.

Length of wing, 7 mm.

Female unknown.

Type locality: Boulder, Colorado.

Type in the American Museum.

This author has identified specimens from Petersboro, Utah, 4-27-35 (F. H. Gunnell); Price, Utah, 7-14-35 (F. C. Harmston) and Paradise, Utah, 5-4-37 (G. F. Knowlton).

Bibio basalis Loew

Bibio basalis Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 11, Comp. work, p. 217.

FEMALE.—Head and body black, coxae rufous, the posterior ones somewhat darker than anteriors; femora, tibiae (except front pair which are shining black, with rufous spurs) reddish, with black tips; basitarsi yellow with black tips, other tarsal joints chiefly black. Inner spurs of front tibiae long, but slightly shorter than outer. Pile of head, body, coxae and femora yellow to reddish yellow; that of tibiae and tarsi brown to black. Wings dusky fumose, darker costally; anterior veins and stigma black, posteriors brown; r-m crossvein equal in length to basal part of Rs.

Length: wing, 5.5-9 mm.

Male unknown.

Type locality: New Hampshire.

Females fitting the description of this species have been examined from British Columbia, Massachusetts, New Hampshire and Utah. McAtee reports a female answering the description (except for size) from Manning, South Carolina, with a wing length of 5.5 mm. This is a rather wide range, and since the males of the species are unknown and the original description is so meager, their identification is by no means certain.

Type in Cambridge Museum of Comparative Zoölogy.

Bibio bryanti Johnson

Bibio bryanti Johnson, 1929, Diptera of Labrador, Psyche, XXXVI, 133.

Bibio lacteipennis Curran (nec Zetterstedt), 1924, Can. Ent. LVI, 250.

Bibio currani Hardy, 1937, Proc. Utah Acad. Sci. XIV, 200-201.

B. currani was a change of name for *lacteipennis* Curran (nec Zetterstedt). New synonymy based upon a study of the type.

Following is the original description of the male:

"Head, antennae and palpi black, pile of eyes long and brown. Thorax black, shining with long black pile. Abdomen black with whitish pile. Legs reddish, with yellowish hairs, coxae and knees black, inner spur of front tibiae about one-half the length of outer one, the posterior tibiae and metatarsi enlarged, the latter about as long as the second and third joints combined. Wings hyaline, the costa, stigma and first and second veins brown. Halteres dark brown."

FEMALE.—With shorter more sparse pile, a few yellowish hairs intermixed with darker pile. Posterior metatarsi not so enlarged as in the male although the hind femora are equally as strong.

Length of wing 8-10 mm.

Type locality: Nain, Labrador.

Type in Cambridge Museum of Comparative Zoölogy.

Also has been recorded from Rama, Labrador and Mt. Revelstoke, B. C.

Bibio bryanti var. *nigrita* Curran

Bibio lacteipennis var. *nigrita* Curran, 1924, Can. Ent. LVI, 250. New combination.

This differs from the typical *bryanti* in having the femora shining black, the posterior pair are somewhat reddish toward bases.

Type locality: Mt. Revelstoke, B. C.

Type in Canadian National Museum.

Bibio carolinus n. n.

(Plate XXXVIII, figs 187a-d)

Bibio afer McAtee (nec Loew), 1923, Proc. Ent. Soc. Wash., vol. 25, No. 3. Change of name. *B. afer* preoccupied by Loew, 1854, Neue Beitrag Zur Kent der Dipt. II.

This species is related to *rufithorax* Wiedemann. Refer to description notes on that species for distinguishing characteristics.

MALE.—Shining black species, except for yellow humeral ridges and reddish tibial spurs. McAtee, in the original description, states that there is a yellowish stripe on the inner side of each hind tibiae, but this appears to be exceptional as most specimens have the legs entirely shining black. Pile of the head, excepting some gray pile on the occiput, and of tibiae and tarsi brownish to black; that of thorax, coxae and abdomen chiefly grayish yellow; pile of femora mixed black and yellow. *Legs*: Inner spurs of front tibiae short, about one-third the length of the outer spurs. The legs have the appearance of being somewhat shortened; posterior tarsal subsegments (fig. 187d). *Wings*: Dusky fumose, all veins and stigma blackish, radio-medial crossvein short, not over one-fourth the length of the basal part of the posterior branch of radius. *Genitalia*: Cleft of ninth sternum broad and shallow. Harpagones slender and rather elongate, curved inward (fig. 187b). Ninth tergum deeply V-shaped on hind margin, cleft three-fourths the length of the segment (fig. 187c).

Length of wing: 6.3-6.5 mm.

FEMALE.—Females differ from males in being of larger size, the pile is much more sparse and that of the abdomen is chiefly yellow;

the pleurae and humeri have dull rufous markings. The length of the head behind the compound eyes is longer than the eye length and the middle of the face behind the antennae with small tubercles (fig. 187a). Head, propleurae, mesopleurae and sternopleurae chiefly bare. Scutellum bright reddish.

Length of wing: 8-9.3 mm.

This is the first report that has been made of the female. Only males were present in the type series.

Type locality: Raleigh, North Carolina.

Type in the United States National Museum.

The writer has studied the type and additional specimens from the type locality May 6-8, 1925 (C. S. Brimley); also specimens from St. Augustine, Florida, March 24, 1939 (W. Benedict).

Bibio carri Curran

(Plate XXXVIII, figs 188a-b)

Bibio carri Curran, 1927, Descriptions of Nearctic Diptera Can. Ent vol LIX, No 4, p. 80.

The male of this species has never heretofore been recorded or described. The writer has examined numerous males taken in copulation at the type locality and at Lethbridge.

MALE.—Head and appendages, body (humeral ridges slightly yellowed posteriorly), coxae and trochanters shining black; eyes with yellow-brown pile; pile of body and legs chiefly yellow and rather sparse, some darker hairs on the tibiae. *Legs:* Robust, the joints seeming somewhat shortened giving them a drawn up appearance, average length of posterior femora 1.6 mm., posterior tibiae 1.5 mm.; femora and tibiae yellow to rufous, dark brown to black apically. Inner spurs of front tibiae a little over half the length of the outer; posterior metatarsi not at all swollen but the subsegments of tarsi are rather short and thick, metatarsi lighter in color than the other subsegments; posterior metatarsi not quite three times as long as wide, about twice as long as inner spurs of hind tibiae and next subsegments (fig. 188a); spurs of hind tibiae short, thick and blunt at apices. Posterior femora clavate, tibiae not noticeably so. *Wings:* Chiefly hyaline, with a slight tinge of yellow fumosity; radio-medial crossvein equal to the length of the basal part of the posterior branch of radius. Anterior veins and stigma yellow-brown, posterior veins lighter in color. *Hypopygium:* Ninth tergum with a narrow median cleft on hind margin, extending not quite half the length of segment (fig. 188b). Harpagones slender, acute at apices.

Length of wing, 4-4.2 mm.

FEMALE.—The female of this species is considerably larger than the male, the wing measuring 5-6 mm. The coxae, trochanters, abdomen and sometimes the thorax are tinged with dark reddish brown. Pi¹ more sparse and shorter; otherwise like the male.

Type locality: Medicine Hat, Alberta.

Type in Canadian National Museum.

The author has examined specimens from this locality and from Lethbridge. Alberta, May 6, 1923 (L. H. Seamens).

Bibio cognatus Hardy

Bibio cognatus Hardy, 1937, New Bibionidae from Nearctic America, Proc. Utah Acad. Sci. XIV, 199-200.

This species is related to *nigrifemoratus* Hardy but is distinguished by its wholly black pile, yellow fumose wings and six segmented antennae. The palpi of the type appeared to be just three segmented but a small first segment may have been overlooked.

Following is the original description:

"Male.—Head black, body chiefly black, posterior border of humeral ridge yellow, pleura and ninth sternite tinged with dark reddish-brown. Coxae, trochanters, femora and proximal half of anterior tibiae reddish-brown, tibiae of the hind two pairs of legs, and all tarsi yellow-red tipped with brown apically; hind femora clavate, tibiae hardly so; posterior metatarsi not enlarged, about one and one-half to twice the length of the next segment; apical half and spurs of the anterior tibiae yellow, inner spurs above one-half the length of the outer. Pile of the head and body sparse and black, that of the posterior part of the abdomen (genital segments), and legs reddish-brown; radio-medial crossvein equal in length to basal part of the radial-sector; fork of the fourth longitudinal vein arising just beyond M-cu crossvein (base of M₂). Length of wing, 4 mm."

Female unknown.

Type locality: Ellery Lake, Tioga Pass, California.

Type in United States National Museum.

Bibio columbiensis Hardy

Bibio columbiensis Hardy, 1938, Can. Ent. LXX, 207-208.

This species is related to *fumipennis* Walker. It is distinguished by the pale femora and darker tibiae and tarsi, longer inner spurs on front tibiae and V-shaped cleft on hind margin of ninth tergum.

Following is the original description:

"Male.—Head, thorax (except yellow anterior margin of humeral ridges), coxae, trochanters and abdomen black. Head with dense,

long, black hair on the face and copious black pile on the eyes. Ocellar tubercle strongly developed, higher than that of *fumipennis*. Pile on dorsum of thorax yellow gray with some darker hairs intermixed, some hairs darker at bases. Pile of pleurae yellow, that of abdomen dense, yellow gray. All tibiae darker than femora, all femora rufous with black tips. Anterior and middle tibiae rufescent with a dark reddish-brown to black stripe running its entire length on the dorsal edge; entire apical one-third to one-half of tibiae sometimes reddish-brown to black. Posterior basitarsi enlarged but cylindrical and not globular, other tarsal segments swollen. Front and mid tarsi chiefly black, somewhat yellowed basally, yellow brown apically, other tarsal segments black. Pile of coxae, trochanters and femora yellow, that of tibiae and tarsi yellow red. Wings yellow fumose, somewhat darker costally; r-m crossvein slightly shorter than the basal part of the Rs. Humeral crossvein distinct.

"Genitalia: Genital cleft extending but a little over one third the length of the segment. Styli narrow and with distinct tufts of dark hair basodorsally. Superior plate (ninth tergum) deeply angulate emarginate, the cleft extending slightly more than half its length; apices obtuse, with edges gently rounded. The ninth tergum of *Bibio fumipennis* cleft over three-fourths its length, the cleft more broad basally and not angulate."

Length of wing: 7-7.2 mm.

Female unknown.

Type locality: Jesmond, B. C.

Type in Canadian National Museum.

Bibio conjunctivus Hardy

Bibio conjunctivus Hardy, 1937, Proc. Utah Acad. Sci. XIV, 200.

This species is related to *albipennis* Say but the sclerites of the abdomen are small and reveal the light gray to dusky conjunctiva; the humeral ridges of both sexes are bright yellow and the female has a conspicuous yellow-red spot on each humeri. Following is the original description:

"Male.—Eyes and labellum light brown, the former with copious brown pile, the rest of the head and dorsum of the thorax, excepting the bright humeral ridges and pale stalks of halteres, shining black. The pleurae, sclerites of the abdomen and legs rufescent-black; all but femora, tibiae and tarsi of the legs and the genitalia, with copious long yellow gray pile, and with dense patch of hair on the mesopleura; pile of the genitalia dark reddish to black, that of the

femore yellow to yellowish-brown, that of the tibiae and tarsi dark brown to black. Posterior femora and tibiae clavate, posterior metatarsi not swollen and slightly longer than succeeding two segments. Inner spur of front tibiae almost one-half the length of the outer. Wings milky hyaline, costal cell with a milky clouding; veins and stigma brown, radio-medial crossvein about one-fourth the length of the basal part of the radial sector.

"Female.—The female differs from the male in having a bright yellow-red spot on the sides of the humeri; pleurae with rufous markings; legs and sclerites of the abdomen tinged with rufous; posterior tibiae not clavate and wings fumose, milky basally.

"Length of wing, 7-8 mm."

Type locality: Plummer I., Maryland.

Bibio conus Hardy

Bibio conus Hardy, 1938, Can. Ent. LXX, 208-209.

Following is the original description:

"The species resembles somewhat *B. xanthopus* Widemann but differs distinctly in having the r-m crossvein one-half the length of the basal part of the radial sector; posterior veins concolorous with the membrane, the posterior tarsal segments slightly swollen but not approaching in size the end of the femora and tibiae.

"Male.—Head, thorax (except yellow humeral ridges), abdomen, coxae and trochanters black. Antennae with eight segments, pile of eyes, occiput, palpi and antennae black, that of face dark brown. Thorax rather sparsely pilose, pile of dorsum yellow-brown, that of pleurae, venter, abdomen (somewhat darker on genitalia), coxae, trochanter and femora yellow-gray, with a few yellow-brown hairs intermixed on femora. Pile of tibia and tarsi yellow to yellow-brown intermixed. Front and mid femora brownish black with a yellow tinge, lighter in the middle and darker on dorsal and ventral edges. Hind femora and all tibiae yellow basally with brown to black tips (tibial spurs rufous), hind femora darkened on apical half. The first two tarsal segments chiefly yellow, the last three chiefly black. Hind femora and tibiae clavate, inner spurs of front tibiae fumose, anterior veins and stigmata dark brown, posteriors concolorous with the membrane. Humeral crossvein pale and slightly interrupted just before the costa. Halteres brownish.

"Female.—The female differs in having the wings yellow fumose, pile of dorsum more yellowed, pleurae, coxae, trochanters and labelum with a yellow tinge; legs chiefly yellow to rufous, hind tibiae

straight or nearly so, tarsal segments slender, and cerci of genitalia yellowish."

Length of wing, 7-8 mm.

Type locality: Churchhill, Manitoba.

Type in University of Minnesota Collection.

Bibio criorhinus Bellardi

Bibio criorhinus Bellardi, 1859, *Dipterologia Messicana*, I, 17.

McAtee reports identifying a male of this species from the Graham Mountains, Arizona, June 1914 (E. G. Holt) and gives the following short description.

"Black except the subequal spurs of front tibiae, and the hind tibiae and tarsi which are rufescent, and narrow bases of front tarsal joints which are yellowish; head, body and coxae clothed with long dark hairs; those of the rather elongate legs shorter. Length of wing, 7 mm."

Type locality: Mexico.

Type in "Collezione del Museo Zoologico di Parigi".

The writer has a Utah species which runs out as *criorhinus* but it is very probably not that species. A Mexican species has also been examined, the male of which fits the *criorhinus* description. The female, however, differs strikingly from any forms which have been observed from the temperate zone. Further acquaintance with materials from Central and South America will no doubt clarify this matter.

Bibio curtipes James

Bibio curtipes James, 1936, *Amer. Mus. Novit.* No. 832, 5-6.

This species approaches *melanopilosus* Hardy but differs in having the legs more extensively yellow, the posterior basitarsi very short, wings less dusky and some pale hair on the thorax and abdomen.

The following is the original description:

"*Female*.—Head, with appendages, thorax and abdomen, wholly black; pile of head black; that of thorax black, intermixed with white; that of abdomen black on the disc, both dorsally and ventrally, a little whitish laterally. Legs yellow, short, the segments thick; the coxae slightly darkened, the apical two or three tarsal segments moderately so; pile very largely black. Halteres black. Inner claw of anterior tibiae about one-half the length of the outer one. Posterior femora clavate, the tibiae not so. Posterior basitarsi barely longer than the second tarsal segment. Wings slightly infumated; the anterior veins blackish, the posterior ones yellowish,

but distinctly darker than the membrane; stigma distinct, black. Crossvein r-m one-fourth the length of the basal part of vein Rs. Length, 6-7 mm.

"*Male*.—Eyes with moderately long and moderately dense black pile. Coxae, trochanters, and femora black; the tibiae and tarsi brownish yellow, the latter more darkened apically. The pile of the body may be entirely black, or there may be a little pale pile on the dorsum of the thorax and on the abdomen laterally. Otherwise as in the female."

Type locality: Boulder, Colorado. Also recorded from Walsenburg, Colo. and Bothwell, Utah.

Type in American Museum.

Bibio femoratus Wiedemann

(Plate XXXIX, fig 189a)

Bibio femorata Wiedemann, 1828, Ausz. Zweifl. Insekten, 1, 79

Bibio fuscipennis Macquart, 1838, Dipt. Nouv. ou peu connus, vol. 1.

Bibio senilis Wulp, 1869, Nogiets over Noord-Amer. Dipt., Tijds. voor Ento. 12, 81-82.

This species is easily recognized by the bright red, contrasting femora and the long inner spurs of front tibiae (fig. 189a).

MALE.—Entirely shining black species, except for the conspicuously rufous femora and the rufescent tibial spurs and humeral ridges; bases of tarsal joints sometimes rufous, and in occasional specimens the entire tibiae are tinged; femora narrowly black tipped. Hair of the head dark, some yellow-gray pile on the face; that of the body, coxae and femora long, pale yellow; tibiae and tarsi with short brown to black hairs. *Wings*: Hyaline to pale yellow fumose, more fumose costally; anterior veins and stigma dark brown, posteriors light brown; r-m crossvein about equal to basal part of vein Rs.

FEMALE.—The female differs in having the pile more sparse, shorter and entirely yellow, except on the tibiae and tarsi; the wings yellow-brown fumose to smoky black.

Length of wing, 7-9 mm.

Type locality given as North America.

Type in Vienna Museum.

This species is very wide spread. Specimens have been examined from the following states and provinces: British Columbia, Colorado, Connecticut, Illinois, Iowa, Kansas, Maryland, Mississippi, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Oklahoma, Ohio, Pennsylvania, Quebec, Saskatchewan, Utah, Virginia and Washington. The females from Iowa have very black wings.

Bibio fluginatus Hardy

Bibio fluginatus Hardy, 1937, Proc. Utah Acad. Sci. XIV, 201.

Following is the original description:

"*Male*.—Head, body, (with the exceptions of pale humeral ridges) and coxae black; tergites of the abdomen somewhat yellowed laterally; femora and succeeding leg joints, except the last three tarsal segments, yellow to rufous with slight dark tips; anterior tibiae somewhat darkened at the base of the spurs. Inner spurs of anterior tibiae shortened, one-third to one-fourth the length of the outer; posterior femora and tibiae rather strongly clavate, the latter slightly thicker; posterior basitarsi noticeably enlarged but not strongly swollen or globular. Pile rather short and more sparse than in most species, that of head dark, that of body, coxae and femora yellow, of tibiae and tarsi yellow to brown intermixed. Knobs of halteres brown, stems ochraceous. Wings yellow fumose, anterior veins and stigma dark brown, posterior veins pale brownish yellow; cross-vein r-m equal in length to basal part of Rs.

"Length of wing, 4 mm.

"Female unknown."

Type locality: Salmon Arm, British Columbia.

Type in the United States National Museum.

Bibio flukei Hardy

(Plate XXXIX, fig. 190a)

Bibio flukei Hardy, 1937, Proc. Utah Acad. Sci. XIV, 202.

This species is readily recognized by the bicolored legs and short globose posterior metatarsi of the male. Following is the original description of the male with additional leg characters:

"*Male*.—Head and appendages, body (except yellow humeral ridges), coxae, trochanters, anterior femora and basal three to four tarsal segments, black; mid and posterior femora yellow on their basal half (basal constriction), dark brown to black on the apical half, front femora dark reddish brown; all tibiae and basitarsi chiefly yellow, all except anterior tibiae, with dark tips. Inner spurs of front tibiae very short, not over one-fourth the length of the outer, posterior femora and tibiae clavate, the latter strongly so, swollen apically, much larger than the femora; posterior basitarsi greatly enlarged and more or less globular, not greatly lengthened and equally as thick as the femora. Pile of the head brown to black, that of the body and legs sparse yellow, some dark pile on the tarsi. Wings yellow fumose, anterior veins and stigma brown,

posterior veins yellow; r-m crossvein equal to the basal part of the Rs; fourth vein arising before m-cu crossvein.

"Length of wing, 6-6.5 mm."

The outer spurs of front tibiae extend about half the length of the metatarsi; the outer spurs of hind tibiae are slender and acutely pointed while the inner are shorter and obtuse. Hind metatarsi only about two and one-half times as long as wide (fig. 190a). Hind femora average 2.5-2.7 mm., hind tibiae 2-2.2 mm.

FEMALE.—Legs more yellowish, all femora brownish, yellow instead of so extensively black, tibiae and first two subsegments of tarsi yellow. Hind tibiae not so clavate, tarsal subsegments slender, metatarsi five times as long as wide.

Length of wing, 7 mm.

Type locality: Cameron Pass, Colorado.

Type in the American Museum.

The writer has examined a good series of specimens from the type locality: Aug. 19-22, 1940 (R. H. Beamer, C. W. Sabrosky) and specimens from Monarch Pass, Colorado, alt. 11,362 ft., Sept. 5, 1938 (D. E. Hardy, A. T. Hardy). It has also been recorded from Pingree Park, and Tennessee Pass, Colorado.

Bibio fraternus Loew

(Plate XXXIX, figs. 191a-b)

Bibio fraternus Loew, 1864, Dipt. Amer., Sept. indig., Cent. 5, No. 8, Compl. Work, p. 216.

Specimens in the Snow Entomological collection determined *articulatus* Say by C. F. Adams belong to *fraternus* but as Say's description is inadequate and his type is apparently lost the position of *articulatus* must be questioned.

This species is related to *abbreviatus* Loew but is distinguished by the more elongate, slender metatarsi and the rufous colored dorsum of the females.

MALE.—Head and appendages, body, coxae and trochanters black. *Legs*: Chiefly yellow to rufous, joints dark tipped; anterior tibiae sometimes dark brown to black. Inner spurs of front tibiae almost as long as the outer. Subsegments of posterior tarsi slender and elongated, metatarsi about three times the length of the inner spurs on hind tibiae and about seven times as long as wide, about equal in length to the next three subsegments (fig. 191a). Posterior femora average 2.6 mm. in length; posterior tibiae, 2.4 mm. Pile of head dark gray to black, body and legs, excepting tibiae and tarsi, with long yellow pile; tibiae and tarsi with short black hairs. *Wings*:

Chiefly hyaline, sometimes slightly yellow fumose, anterior veins and stigma brown, posterior veins very pale, almost concolorous with the membrane. Crossvein r-m equal to basal part of the posterior branch of radius. Ninth tergum with a V-shaped cleft on hind margin, extending about half the length of the segment (fig. 191b).

Length of wing 5-6 mm.

FEMALE.—Differs in having all pile, except that of tibiae and tarsi, short, sparse and pale. The coxae, trochanters and dorsum of the thorax are rufous, pleurae usually with rufous markings. Wings yellow to yellow-brown fumose, anterior veins darker than the membrane.

Length of wing, 5.8-6.6 mm.

Type locality: District of Columbia.

Type in Cambridge Museum of Comparative Zoölogy.

This species is very widespread and has been seen from the following states and Canadian provinces: Colorado, Connecticut, Illinois, Iowa, Kansas, Kentucky, Maryland, Manitoba, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Nova Scotia, Ohio, Oklahoma, Ontario, Tennessee, Utah, Virginia, and Wisconsin. The writer has studied the type.

Bibio fumipennis Walker

Bibio fumipennis Walker, 1848, List of the specimens of Dipterous Insects in the collection of the British Museum, 1, 122.

MALE.—Head and body (excepting yellow posterior edge of humeral ridges), coxae and trochanters black. Head with copious dark pile, that of the body and legs yellow (tibiae and tarsi reddish yellow). *Legs:* Femora and succeeding leg joints yellow to rufous, only the femora dark tipped. Inner spurs of front tibiae but slightly over one-third as long as outer; posterior femora and tibiae clavate; posterior metatarsi enlarged and swollen but not globular, about as long as next two subsegments. *Wings:* Slightly yellowish fumose, anterior veins and stigma brown, posterior veins concolorous with membrane; crossvein r-m almost equal to the basal part of the Rs.

FEMALE.—Related to *rufithorax* Wied. but differing in that the legs are yellow to rufous and the wings dark, yellow-brown fumose. Head and appendages black, dorsum of thorax and legs, rufous; pleurae with dark brown to black markings; halteres yellow-brown; abdomen dark brownish red, cerci yellow. Pile short, chiefly red-

dish yellow. Wings yellow fumose, darker costally, anterior veins and stigma yellow-brown, posterior veins concolorous with the membrane.

Length of wing, 7.5-9 mm.

This is the first time the female of this species has been described or reported, as far as is known by this writer.

Type locality: St. Martin Falls, Albany River, Hudson Bay.

Type in British Museum.

Specimens have been examined from Alaska, Alberta, British Columbia, New York, Ontario and Utah. It has also been reported from New Hampshire.

Bibio holtii McAtee

(Plate XXXIX, fig. 192a)

Bibio holtii McAtee, 1921, Proc. U. S. Nat. Mus. vol. 60, Art. 11, p. 11.

Related to *femoratus* Wied. but easily separated by the short inner spurs of front tibiae.

MALE.—Head, body, coxae and trochanters black; femora bright yellow to rufous, tibiae and tarsi, except for rufous anterior tibial spurs, brown to black. Pile of the head, tibiae and tarsi dark, otherwise yellow. *Legs*: Inner spurs of front tibiae short, about one-third to one-fourth the length of the outer (fig. 192a); posterior femora and tibiae clavate, hind metatarsi slightly enlarged. *Wings*: dusky or slightly yellow fumose; anterior veins and stigma brown, posterior veins concolorous with the membrane; r-m crossvein almost equal to the basal part of Rs.

Length of wing, 6-7 mm.

FEMALE.—The female differs in having dark yellow fumose wings, and shorter pile. This is the first report of the female.

Length of wing 8 mm.

Members of this species are the strongest fliers of the Bibionidae that have been observed by the writer, they are usually taken in mountain regions hovering high above the ground, ordinarily well out of reach of the insect net.

Type locality: Graham Mts., Arizona.

Type No. 24700 in United States National Museum.

Specimens have been examined from many localities in the following western states and Canadian province: Arizona, British Columbia, Colorado, Oregon, Utah, Washington and Wyoming.

Bibio inaequalis Loew

(Plate XXXIX, figs. 193a-d)

Bibio inaequalis Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 8, Com. Work, 218-214.

Bibio fumidus Coquillett, 1899, Report on Diptera of the Commander Islands, 843.

Bibio simplicis Curran, 1923, Can. Ent., Vol. 55, p. 245. New synonymy based upon comparison of type males.

The typical specimens of *inaequalis* from the Far North are larger and not so brightly rufous as our Eastern United States specimens, and the temperate region form may prove to be a distinct subspecies.

MALE.—Head, body (except pale humeral ridges), coxae and trochanters black; femora and succeeding leg joints reddish-brown to rufous with dark tips; anterior tibiae and last three tarsal segments usually darker. *Legs*: Inner spurs of anterior tibiae not one-half the length of the outer (fig. 193b); femora swollen, the posterior ones and tibiae clavate; posterior metatarsi enlarged and slightly longer than the next two subsegments. Pile of head brown to black, that of body and coxae pale yellow, of the succeeding leg joints yellowish-red, with some darker hairs on the tibiae and tarsi. *Wings*: Pale yellowish fumose, anterior veins and stigma brown, posterior veins, except yellowed basal portions, concolorous with the membrane; r-m crossvein about equal in length to basal part of R_4 . *Genitalia*: Ninth sternum cleft almost half its length, sides of cleft almost straight, bottom undulated. Harpagones long and slender, strongly curved (fig. 193d). Ninth tergum almost as long as wide, deeply cleft on hind margin; cleft extending about three-fourths the length of the sclerite (fig. 193c).

FEMALE.—The female differs in having shorter, all yellow pile and only the head black; notum and pleurae rufous, sometimes with discolored vittae on the dorsum; abdomen yellow-brown; femora and succeeding leg joints more yellow.

Length of wing, 6-7.5 mm.

Type locality: Sitka, Alaska.

Type in Cambridge Museum of Comparative Zoölogy.

The species has been reported from Unalaska, Iditarod and Saldovia, Alaska, Copper Island and Karagi Island, Kamchatka; Nordegg, Alta.; and Banff, Alta.

The writer has examined the type series and has also identified specimens from Labrador, Newfoundland, Wyoming, New York and Massachusetts.

Bibio kansensis James

(Plate XXXIX, fig. 194a)

Bibio kansensis James, 1936, Amer. Mus. Novit. No. 832; 6.

This species is closely related to *curtipes* James but differs in having more pale hair on the thorax and abdomen and legs more rufous. The following is the original description with additional notes on the leg characters.

Female.—Black, the pile of the body mostly grayish; legs short, thick, a somewhat obscure yellow in color, the coxae and trochanters darkened, the pile of the legs grayish to black, that of the tibiae stubby; the inner spur of the anterior tibiae not more than one fourth the length of the outer one; posterior basitarsi flattened, barely longer than the second tarsal segment. Wings dusky hyaline; veins brown, heavier near the costa; stigma brown; cross-vein r-m one-third to one-fourth the length of the basal part of the radius sector. Length, 5-6 mm. (the type specimens studied by the writer measured 4-4.3 mm., wing and body).

Male.—Similar to the female; the pile of the body tends to be longer and darker, and the legs are slightly darkened."

The outer spur of front tibiae extends about two-thirds the length of the metatarsus; spurs of middle tibiae slender, acutely pointed, extending half the length of the metatarsus; spurs of hind tibiae thick and broadly rounding at apices. Hind metatarsus not much over twice as long as wide and about one and one-half times as long as the next subsegment (fig. 194a).

Type locality: Kirwin, Kansas.

Type in American Museum of Natural History.

Up to date this species has only been reported from Kansas. The writer has studied paratopotypes.

Bibio knowltoni Hardy*Bibio knowltoni* Hardy, 1937, Proc. Utah Acad. Sci. XIV, 202-203.

This species is related to *abbreviatus* Loew. It is distinguished by the short inner spurs of front tibiae and the dark posterior veins of the wing. Following is the original description:

Male.—Head and appendages, body (excepting pale humeral ridges), coxae and trochanters black; posterior femora and tibiae yellow to rufous, with dark tips, the former clavate; middle femora and tibiae slightly darker in color and front femora and tibiae dark rufous with black markings; basal half of anterior tibiae entirely black, spurs rufous. Inner spurs one-third to one-fourth the length

of the outer; metatarsi of all legs yellow basally and dark brown to black apically; other segments brown to black; posterior metatarsi not swollen and rather short, about one and one-half times the length of the next segment. Pile of the eyes brown, that of the face gray, some dark pile on the occiput and that of the thorax and abdomen copious, long, grayish yellow; pile of femora yellow of the tibiae and tarsi darker costally, veins and stigma brown, the anteriors darker than the posteriors; r-m crossvein about equal in length to the basal parts of the Rs.

"Male Genitalia.—Genitalia quite bare with but sparse yellow hairs. Superior plate (ninth tergum) broad, its posterior margin deeply concave, the cleft extending about two-thirds the length of the segment. Stylus narrow and pointed.

"Female.—The female differs in having shorter, all pale pile and the coxae and trochanters rufous; the pleurae sometimes has slight rufous markings. Wings more yellowed.

"Length of wing 4.5-6 mm."

Type locality: Granger, Utah.

Type in the United States National Museum.

Added distribution: Pullman, Washington and Paradise Valley Mt., Rainier, Washington, Aug. 30, 1928 (M. D. L.)

Bibio knowltoni var. *paltidus* Hardy

(Plate XXXIX, fig. 195a)

Bibio knowltoni var. *paltidus* Hardy, 1937, Proc Utah Acad Sci. XIV, 203.

Following is the original discussion of this variety with additional notes on the leg characters for the species:

"This variety differs from knowltoni in that the wings are dusky to smoky hyaline and not yellow fumose, the veins and stigma black, somewhat lighter basally. Males are much more densely pilose, and the pile of the body and coxae chiefly gray. Posterior legs of male red instead of yellow as in the preceding variety."

Subsegments of posterior tarsi rather short and broad, metatarsi three and one-half to four times as long as wide and about twice as long as tibial spurs (fig. 195a). Posterior femora average 2 mm. in length, posterior tibiae 1.7 mm.

Type locality: Provo, Utah.

Type in Brigham Young University Collection, Provo, Utah.

The species has been identified from numerous localities in Utah.

Bibio labradorensis Johnson

Bibio labradorensis Johnson, 1929, *Diptera of Labrador*, *Psyche*, vol. XXXVI, No. 2, 183.

This species is related to *monstri* James but is distinguished by the valine wings and the yellowish pile on the thorax.

MALE.—Head and appendages, body (except pale humeral ridges), coxae, trochanters and femora black; tibiae and tarsi chiefly yellow; anterior tibiae and three apical joints of tarsi somewhat brownish. *Legs:* Inner spurs of anterior tibiae short, not more than one-third to one-fourth the length of the outer; posterior femora and tibiae clavate, tarsal joints swollen, the metatarsi very noticeably enlarged and cylindrical. Pile of the head chiefly brown, some gray pile on the face; that of body and legs yellowish. *Wings:* Hyaline, anterior veins and stigma light yellow to brownish, posterior veins concolorous with the membrane; crossvein r-m about equal in length to the basal section of the posterior branch of radius.

Length of wing, 6 mm.

Female unknown.

Type locality: Nain, Labrador.

Type in Cambridge Museum of Comparative Zoölogy.

The species has been observed from Camp 327, Alaska. Alaska Engineer Commission, 5-11-12, (J. M. Aldrich); Alberta, Canada, and Bedley, B. C., July 25, 1923 (C. B. Garrett).

Bibio lobatus Hardy

Bibio lobata Hardy, 1937, *Proc. Utah Acad. Sci.* XIV, 203

This species is somewhat related to *knowltoni* Hardy but is distinguished by the yellow to red coxae and trochanters, the yellowish anterior portion of mesonotum and the pale tinge to the pleurae and abdomen. Following is the original description:

Female.—Head chiefly black, appendages yellow-brown; meta and mesonotum black, tinged with yellow on the posterior margin, pronotum yellow on its lateral margins, marked with dark brown to black above; humeral ridges bright yellow; pleurae and abdomen yellow-red; legs, except darker yellow-brown anterior tibiae, bright yellow, segments slightly brownish tipped. Inner spurs of front tibiae short, one-third to one-fourth the length of the outer; front femora strongly swollen, hind femora clavate; hind tibiae straight, posterior basitarsi two times the length of the next segment. Pile short, sparse and yellow, except for some darker hairs on the tibiae and tarsi. Knobs of halteres ochraceous, stems yellow. Wings

slightly yellow fumose, veins and stigma yellow to light brown; r-m crossvein about equal to basal part of the Rs.

"Length of wing, 6.5-7.5 mm.

"Male unknown."

Type locality: Sierra Co., California.

Type in American Museum of Natural History.

Bibio longipes Loew

(Plate XXXIX, figs. 196a-b)

Bibio longipes Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 12, Compl. Work, 217-218.

This species is related to *slossonae* Cockerell but has the thorax and legs pale haired. This is one of the few species of *Bibio* which occur in the fall of the year.

MALE.—Usually entirely shining black, except for pale humeral ridges and tibial spurs; in some specimens the posterior tibiae and tarsi are rutilous. Pile of head copious, brown to black, that of body pale yellow to reddish. *Legs*: Inner spurs of anterior tibiae very short, not over one-fourth the length of the outer; each inner spur sharply pointed; outer spur extends about one-third the length of the long slender metatarsus (fig. 196a). Hind legs elongate, femora and tibiae clavate; posterior metatarsi swollen and cylindrical, about three times as long as wide, spurs of hind tibiae acute (fig. 196b). *Wings*: Hyaline to slightly yellow fumose, veins and stigma brown, the anteriors darker; crossvein r-m equal to basal part of the posterior branch of radius.

FEMALE.—The female differs in having the entire thorax, coxae and succeeding leg joints yellow to rufous (last three tarsal joints somewhat brownish). Abdomen sometimes tinged with rufous. Wings more yellow fumose. Pile all pale and shorter.

Length of wing, 5.3-5.6 mm.

Type locality: District of Columbia.

Type in Cambridge Museum of Comparative Zoölogy.

The species has been examined from the following states and Canadian provinces: Alberta, Colorado, Manitoba, Maryland, Massachusetts, Minnesota, New Brunswick, New York, North Carolina, Nova Scotia, Ohio, Ontario, Utah, Virginia and Washington. It has also been reported from Arizona and New Jersey.

The specimens from Utah and Colorado have the dorsum of female discolored with blackish.

Bibio melanopilosus Hardy

(Plate XXXIX, figs. 197a-c)

Bibio melanopilosus Hardy, 1936, Proc. Utah Acad. Sci. vol. XIII, 195.

This species differs from *curtipes* James in that the pile and legs are entirely black, legs never extensively yellow.

MALE.—Chiefly shining black, except for a slight tinge of reddish-brown on the humeral ridges and the rufous tibial spurs. Pile chiefly black, with a few yellow hairs intermixed on the dorsum. *Legs*: Rather short; inner spurs of front tibiae very short, not over one-fifth to one-fourth the length of the outer; hind femora clavate, tibiae hardly so; posterior metatarsus not swollen and less than twice the length of the next subsegment. Metatarsus one-third to one-fourth as wide as long; spurs of hind tibiae very flat, blunt and rounding (fig. 197b); hind femora average, 2.0 mm. in length, hind tibiae 1.8 mm. *Wings*: Dusky hyaline, slightly darker costally, subcostal cell brownish fumose. Veins and stigma dark brown, posteriors not so dark as the anteriors; r-m crossvein one-fourth the length of the basal part of Rs. Basal portion of m-cu crossvein and median portion of m partially interrupted (fig. 197a).

FEMALE.—The female differs in having shorter, less dense pile with some grayish pile on the abdomen and the face. Wings more dusky, veins and stigma blackish. Legs tinged with rufous, front femora strongly swollen and rutilous. Hind femora average 1.7 mm. in length, tibiae, 1.5 mm.

Length of wing, 5-6 mm.

Type locality: Spanish Fork, Utah.

Type in Brigham Young University Collection, Provo, Utah.

The species has been observed to be especially common in Utah County, Utah (it is the most abundant species found in the vicinity of Spanish Fork and Provo, around the last of April), and has been examined from numerous localities in Utah.

Bibio melanopilosus var. *biseptus* Hardy*Bibio melanopilosus* var. *bisepta* Hardy, 1937, Proc. Utah Acad. Sci. XIV, 204.

Following is the original description:

Male.—Entirely shining black, except slightly tinged tibial spurs, with pale yellow to gray pile on the body, coxae and femora; eyes black pilose; face chiefly gray; tibiae and tarsi black haired. Pile of the dorsum short and sparse, otherwise quite long and more copious. Inner spurs of front tibiae not over one-fourth the length

of the outer; posterior femora clavate, tibiae straight or nearly so; posterior metatarsus not swollen, first segment about one and one-half the length of the succeeding segment. Wings dusky hyaline, smoky costally; veins and stigma black, anteriors darker than posteriors; r-m cross-vein about one-fourth the length of Rs. Palpi four jointed, the second joint enlarged, larger than the others. First two joints of antenna smaller in width than succeeding segments, although equal in length.

"Female.—The female differs in having generally shorter pile (all pale on the head), propleurae with a fringe of long yellow hairs, and the wings more dusky. Anterior tibial spurs of the female are often entirely black.

"The adults of this species were taken in large numbers on Dactylis glomerata L. and the larvae were found in the roots of this grass. The adults were observed for a period of several hours but they gave no indication of feeding."

Type locality: Brigham Young University Campus, Provo, Utah.

Type in Brigham Young University Collection.

This variety is common in Utah.

Bibio mickeli Hardy

Bibio mickeli Hardy, 1927, Proc. Utah Acad. Sci. XIV, 204-205.

This species is related to *femoratus* Wied. and to *utahensis* Hardy, it is distinguished by the pale posterior veins of the wing and by the rufous coxae and trochanters of the females. Following is the original description:

"Male.—Entirely shining black, except for yellow humeral ridges, rufous tibial spurs, yellow bases of metatarsi and sometimes a slight tinge of red on the tibiae. Pile of head black, that of face very dense; pile of body, coxae and femora pale yellow, long, and copious; that of the tibiae and tarsi chiefly black and more bristly. Inner spurs of front tibiae long, almost as long as outer; hind femora and tibiae clavate; hind basitarsi not swollen, at least twice as long as second tarsal segment. Wings hyaline, anterior veins and stigma dark brown, posterior veins concolorous with the membrane; cross-vein r-m equal in length to the basal part of the Rs.

"Male Genitalia.—Coxites broad, genital cleft over one-third the length of the segment. Styli narrow and tapering. Superior plate gently concave, cleft not over one-fourth the length of the tergite. Pile of genitalia yellowish to reddish, longer pile on posterior margin of ninth sternite.

"Female.—The female differs in having shorter pile, yellow on the head; coxae (at least anterior pair), trochanters and femora rufous; wings yellow-brown fumose, anterior veins and stigma black, posteriors brown.

"Length of wing, 8-9 mm."

Type locality: Prontenac, Minnesota.

Type in University of Minnesota Collection.

Species is now known from the following states and Canadian province: British Columbia, California, Utah and Wyoming.

Bibio monstri James

(Plate XXXIX, figs. 198a-c)

Bibio monstri James, 1986, Amer. Mus. Novit. No. 832; 3.

This species is related to *labradorensis* Johnson but is distinguished by the black femora and black pile of the thorax.

MALE.—Head, thorax, abdomen, coxae, trochanters, femora and apical three tarsal joints black; tibiae and basitarsi yellow to rufous with dark tips, anterior tibiae somewhat darker, usually with black markings. *Legs:* Inner spurs of front tibiae not over one-fourth the length of the outer; posterior femora and tibiae clavate, the latter strongly so; posterior basitarsi swollen and longer than succeeding two subsegments. Pile of head, dorsum of thorax, coxae, trochanters, middle and front femora black; posterior femora, all tibiae and tarsi grayish to yellow pilose; pile of pleurae and anterior part of abdomen gray to blackish, yellow-gray to whitish on abdomen posteriorly. *Wings:* Chiefly hyaline with a slight tinge of yellow fumosity, darker costally; anterior veins yellow to brown, stigma pale yellow, posterior veins concolorous with the membrane; crossvein r-m about one-half the length of the basal part of Rs. *Genitalia:* The cleft of the ninth sternum extends about one-third the length of the segment; the distal portion of the sternum with characteristic patches of long hairs on outer edges, otherwise rather sparsely pilose (fig. 198a). Harpagones narrow (fig. 198b) and chiefly light colored, with a black spot basally. Ninth tergum deeply cleft, the cleft extending about three-fourths its length (fig. 198c).

Length of wing, 5.6-6 mm.

FEMALE.—The female differs in having the wings more yellow fumose, femora rufous and the pile short, yellow to reddish. This is the first report of this sex.

Type locality: Trail Ridge Road, Rocky Mountain National Park, Colorado, 12,200 feet. Paratypes were from Estes Park, Au-

gust, 1892 (Snow). The writer has examined a series of paratypes and specimens from Pikes Peak, Colorado, August 8, 1904; Mt. Audubon, Colorado, 7-20-36 (Alexander), and Logan, Utah, 5-5-37 (F. C. Harmston). The type is in the American Museum of Natural History.

Bibio necotus Hardy

Bibio necotus Hardy, 1937, Proc. Utah Acad. Sci. XIV, 205-206.

This species is characterized by the elongate inner spurs of front tibiae and the short radio medial crossvein. It is the only species known to the writer that possesses this combination of characters. Following is the original description:

Male.—Chiefly shining black except for a slight tinge of rufous on the humeral ridges, tibial spurs and tibiae. Pile very dense, long and brown to black. Inner spurs of front tibiae but little shorter than outer spurs; posterior femora and tibiae slightly clavate; hind metatarsi not enlarged, about twice as long as succeeding segment. Wings hyaline, anterior veins and stigma brown, posterior veins pale brown to yellow; r-m cross-vein about one fourth the length of the basal part of the Rs.

"Length of wing, 7.5-9 mm.

Female.—The female differs in having shorter, more sparse and yellow-gray pile on the thorax and abdomen. Posterior tibiae not clavate. Otherwise fitting the description of the male."

Type locality: San Francisco, California. Larval host plant, *Erigeron glaucus*.

Type in Cornell University Collection.

Added distribution: Pullman, Washington, and Berkeley, California, March 16, 1931.

Bibio neojacobi n. n.

Bibio jacobi Hardy, 1938, Can. Ent. LXX, 209. Name preoccupied by *Bibio jacobi* Villeneuve, 1924, Encyc. Ent. Dipt. I, 5.

This species is related to *atripilosus* James but is distinguished by its yellow-brown fumose wings. Following is the original description:

Male.—Head, thorax (excepting yellowed humeral ridges) and abdomen black. Pile of head chiefly black, with some gray hairs on the face, that of thorax and abdomen yellow. Legs chiefly shining black with the bases of the tibiae and basitarsi yellowish, spurs rufous. Anterior femora strongly swollen, inner spurs of anterior tibiae short, approximately one-third the length of the outer. Pos-

terio femora and tibiae clavate. Posterior basitarsi not strongly swollen and rather elongate, twice as long as second tarsal segment. Pile of coxae, trochanters and femora yellow, that of tibiae and tarsi chiefly brown to black. Wings yellow brown fumose, r-m cross-vein equal in length to the basal part of the radial sector. Posterior veins and stigmata brown, anterior veins yellow to yellow brown. Humeral crossvein obsolete and interrupted, being but a short pale stump arising from the subcostal vein.

"Length of wing, 7-7.5 mm.

"Female unknown."

Type locality: Dunn Peak, British Columbia.

Type in Canadian National Museum.

Bibio neojacobi var. *rufitibialis* Hardy

Bibio jacobi var. *rufitibialis* Hardy, 1938, Can. Ent. LXX, 209-210.

This variety differs from the typical in having the base of femora rufous with apices brunnaceous and the tibiae and first two to three subsegments of tarsi chiefly rufous.

Male genitalia: Ninth sternum rather broad, cleft a little over one-third its length; harpagones slender, acute at apices. Ninth tergum with a U-shaped cleft on hind margin, extending two-thirds its length. Pile of genitalia brown to black.

Type locality: Dunn Peak, B. C.

Type in Canadian National Museum.

Bibio nervosus Loew

(Plate XXXIX, figs. 199a-c)

Bibio nervosus Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 4. Compl. work, 214.

Bibio variabilis Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 7. Compl. work, 215-216.
Type in Cambridge Museum.

Comparison of Loew's types of *nervosus* and *variabilis* proved these to be conspecific and the name *nervosus* is given page priority. McAtee⁷³ states that *nervosus* Loew is very similar to *xanthopus* Wied. but differs in having duskier wings and broader front tibiae, it actually runs into the group having the inner spurs of front tibiae elongated, almost equal to the outer in length. It is distinguished from *xanthopus* by the long inner spurs.

MALE.—Head, body, coxae and femora (for the most part) black; the middle and hind femora often rufous basally, sometimes femora almost entirely rufous; middle and hind tibiae and first one to three joints of all tarsi, rufous basally and dark apically, the last two to

three tarsal joints usually entirely dark. *Legs*: Inner spurs of anterior tibiae relatively long, being but slightly shorter than the outer (fig. 199c); posterior femora and tibiae slightly clavate, posterior basitarsi not enlarged, twice as long as second tarsal subsegment. Pile usually gray to black rather long and dense, some specimens have chiefly yellow pile on the dorsum. *Wings*: Hyaline, anterior veins and stigma brown, posteriors concolorous with the membrane; crossvein r-m equal in length to basal part of Rs. *Genitalia*: Pile of genitalia mostly long and dark with some yellow hair intermixed. Ninth sternum broad and short, cleft extending a little over one-third the length of the segment (fig. 199b). Harpagones comparatively narrow and apparently pointed from the ventral view. Ninth tergum cleft to about its middle, and V-shaped (fig. 199a).

FEMALE.—The female differs in having shorter, all yellow, pile; all leg joints rufous with dark tips (coxae sometimes dark), and the wings yellow to yellow-brown fumose.

Length of wing, 6.5-10 mm.

Type locality: Sitka, also New Hampshire specimen in type series.

Type in Cambridge Museum of Comparative Zoölogy.

The species is more common in the western portion of the United States but has a rather wide range. The writer has studied the type series and has identified specimens from the following states, possessions and provinces: Alaska, Alberta, British Columbia, California, Idaho, Kansas, Manitoba, Michigan, Missouri, Montana, New Brunswick, Newfoundland, Ontario, Oregon, Quebec, Utah and Washington.

Bibio nigrifemoratus Hardy

Bibio nigrifemoratus Hardy, 1937, Proc. Utah Acad. Sci. XIV, 206.

This species is related to *atripilosus* James but is distinguished by its smaller size, the dense black pile of the dorsum, shorter inner spurs of front tibiae, yellowish fumose wings and shorter radio-medial crossvein. Following is the original description:

"Male.—Head, body (except pale humeral ridges), coxae, trochanters and femora (for the most part) black; posterior and mid-femora chiefly black or brownish red, usually slightly rufous apically; front femora with a longitudinal stripe of rufous down their middles; front tibiae rufous, except for darkened portion at the base of the spurs, mid and hind tibiae and joints rufous, slightly darker apically, other tarsal segments brownish. Inner spurs of

front tibiae very short, being but one-fifth to one-fourth the length of the outer; posterior femora and tibiae clavate, the latter slightly thicker; posterior basitarsi not swollen and two times as long as next segment. Pile of eyes and occiput copious, black, that of face gray to black; dorsum of thorax with long, black pile, intermixed with yellow, in a few cases the yellow pile is predominant; pile of pleurae, coxae and femora yellow to gray; that of tibiae and tarsi brown, with yellow hairs intermixed. Wings hyaline to slightly yellow fumose, or dusky, anterior veins and stigma dark brown, posterior veins light brown to yellowish gray; r-m crossvein one-half to equal in length to the basal part of the Rs.

"Length of wing 4.5-5 mm.

"*Female*.—The female differs in having all pile short and yellow, all femora yellow to rufous, anterior coxae slightly so, and the wings more dusky yellow fumose."

Length of wing, 5-5.5 mm.

Type locality: Monte Lake, British Columbia.

Type in Canadian National Museum.

Bibio nigrifemoratus var. *gilvus* Hardy

Bibio nigrifemoratus var. *gilvus* Hardy, 1937, Proc. Utah Acad. Sci. XIV, 206.

This variety differs in having the pile of dorsum entirely yellow, that of pleurae, coxae, femora and abdomen gray to yellow. Hairs of tibiae and tarsi reddish brown. Femora often tinged with reddish-brown at their apices.

Type locality: Ogden, Utah.

Type in the United States National Museum.

Added distribution: Idaho: Moscow (J. M. Adrich). Montana: East Shore, Flathead Lake, April 21, 1934 (R. D. Kichmann). Utah: Petersboro, April 27, 1938 (Knowlton, Hardy, Stains); Cache Jc., June 27, 1938 (Knowlton, Hardy, Stains); Kanosh, June 27, 1938 (Knowlton, Harmston); Trenton, April 27, 1938, on Alfalfa (Knowlton, Hardy); Centerville, April 27, 1939 (Knowlton, Harmston); Pleasant View, April 25, 1939 (Knowlton, L. D. Bischoff); Sardine Canyon, April 22, 1939 (Knowlton, L. D. Bischoff) and Mantua, April 22, 1939 (Knowlton, Bischoff).

Bibio nigripilus Loew

Bibio nigripilus Loew, 1864, Dipt. Amer. Sept. Indig., Cent. 5, No. 10, Compl. work, 214-215.

Bibio lucens Hardy, 1937, Proc. Utah Acad. Sci. XIV, 203-204. This appears to be a synonym. The original description states that the hind metatarsi are one and one-half times as long as next subsegments but the types have not been compared to see if this character is good.

MALE.—Head, body (except yellow humeral ridges), coxae and trochanters shining black. Femora, tibiae (front tibiae brownish) and tarsi yellow to rufous, all joints dark tipped. *Legs*: Inner spurs of front tibiae but slightly shorter than outer; posterior femora and tibiae clavate; posterior basitarsi not swollen, about two times as long as second tarsal subsegments. Pile of head and thorax chiefly black, long and copious; that of coxae gray to black; of the femora and succeeding leg joints yellow-red; the pile of the abdomen gray on the anterior half and yellow posteriorly. Knobs of halteres brown, stems ochraceous. *Wings*: Hyaline, slightly fumose costally; anterior veins and stigma brown, posteriors concolorous with the membrane; crossvein r-m almost as long as basal part of Rs.

Length of wing, 5-6 mm.

Female unknown.

Type locality: Winnipeg, Canada.

Type in Cambridge Museum of Comparative Zoölogy.

Specimens fitting the description of *nigripilus* have been examined from Great Falls, Virginia, IV-23-19 (C. T. Greene); Montreal, New York; Bellmore, Indiana, July 2, '89 (A. E. Thomas); C. Mo., May (C. V. Riley); Jackson, Minn., 28 May, 1907; Covey Hill, Que., 31-5-1924, (P. Armstrong) and Brookings, South Dakota, April 24, 1925 (N. C. Severin). *B. lucens* was described from Ontario and Minnesota.

Bibio painteri James

Bibio painteri James, 1936, Amer. Mus. Novit. No. 832, p. 2.

This species is very close to *alexanderi* James. The following is James' discussion of it with added notes on leg characters:

"Related to *alexanderi*. It differs as follows: The dorsum of the thorax, in the female, is extensively marked with black; the extent of the black is variable, and may cover the large part of the dorsum. The pile of the tibiae is pale in both sexes and similar to that of the femora. In the male, the posterior tibiae, as well as the femora are clavate. The eyes are black-haired, and there is usually a considerable amount of pale pile on the lower part of the occiput."

The inner spurs of front tibiae almost half as long as the outer,

the outer spurs extending less than half the length of the metatarsi. Inner spurs of hind tibiae rather blunt, outer ones slender and acute. Hind metatarsi less than four times as long as wide.

Length: body and wings, 4.2-4.7 mm.

Type locality: Manhattan, Kansas.

Type in American Museum.

The writer has studied paratopotypes and has identified specimens from Stillwater, Oklahoma, 3-25-39 (K. C. Emerson); Columbus, Ohio, 23-IV-34 (R. H. Painter) also from Arizona and Colorado.

Bibio pingreensis James

(Plate XXXIX, fig. 200a)

Bibio pingreensis James, 1936, Amer. Mus. Novit. No. 832, p. 4.

Following is the original description with added notes on the leg characters:

"Related to *inaequalis* Loew, but the posterior basitarsi are not so noticeably enlarged and the legs are differently colored; it is more robust than *longipes* and the structure of the posterior tarsi is different.

"*Male*.—Head, with appendages, thorax and abdomen black. Head wholly black-haired, the eyes with copious black hair. Thorax, abdomen, and legs with long yellowish pile; a little gray pile on the mesopleura; some short black pile on the tibiae and tarsi. Coxae, trochanters, femora and anterior tibiae black; the spurs on the anterior tibiae yellow, the inner spur one-third the length of the outer one; posterior femora strongly clavate, the constricted basal part yellowish; middle tibiae brown; posterior tibiae yellowish to brown; tarsi brown, the basitarsi yellowish to brown. Posterior basitarsi slightly enlarged, but cylindrical, rather than globular, as in the related species. Wings whitish or slightly grayish hyaline; the strong veins brown; the posterior ones barely discernible from the membrane; crossvein r-m about one-half as long as the basal section of vein Rs. Length, 7-8 mm.

Outer spurs of front tibiae extending less than half the length of the metatarsi. Spurs of middle tibiae slender and acute; outer spurs of hind tibiae acute, inner ones rather blunt at apices. Hind metatarsi more than three and one-half times as long as wide (fig. 200a). Hind femora average 3.4 mm.; hind tibiae 2.7 mm.

Type locality: Mummy Pass, Alpine Zone, Pingree Park, Colorado.

Type in the American Museum.

Specimens have been identified from Cameron's Pass, Colorado, Aug. 20, 1940 (R. H. Beamer) and Logan Canyon, Utah, 9-11-37 (G. F. Knowlton, F. C. Harmston).

Bibio rufalipes Hardy

Bibio rufalipes Hardy, 1937, Proc. Utah Acad. Sci. XIV, 207.

This species is related to *xanthopus* Wiedemann but is distinguished by the concolorous posterior veins of wing, the reddish markings on the thorax and abdomen of the males and the wholly rufous thorax and legs of the females.

Following is the original description:

"*Male*.—Head chiefly black, appendages brownish; pile of eyes short and brown, that of face long, copious gray. Dorsum of thorax, for the most part, black, humeral ridges yellow, posterior margin rufous; pleurae with some rufous markings or tinges of reddish. Abdomen black, except lateral margins of tergites which are reddish. Pile of thorax and abdomen long, grayish yellow, more yellow hair on the posterior part of the abdomen. Coxae and trochanters somewhat tinged with red or reddish-brown; femora, tibiae (except more brownish anterior tibiae) and first two to three tarsal joints of legs chiefly yellow, with some darker hairs on the tibiae and tarsi. Inner spurs of anterior tibiae very short, not over one-fourth the length of the outer; posterior femora and tibiae clavate, the latter rather strongly swollen, larger than the femora in width; posterior basitarsi not enlarged, about as long as next two segments. Wings slightly yellow-fumose, anterior veins and stigma yellow-brown, posterior veins concolorous with the membrane; cross-vein r-m about equal in length to the basal part of the Rs.

"*Female*.—The female differs in having the entire thorax, coxae and trochanters rufous, the abdomen testaceous, or with a reddish cast; the tibiae and tarsi darker in coloration than the femora, those of the anterior legs dark red-brown to black, other tibiae and tarsi darker rufous to brown. All pile shorter and yellow, and wings darker fumose.

"Length of wing, 6-6.5 mm."

Type locality: Waco, Texas.

Type in United States National Museum.

Bibio rufithorax Wiedemann

(Plates XXXIX-XL, figs. 201a-f)

Bib-(10) *rufithorax* Wiedemann, 1828, Ausz. Zweifl. Ins. 1, 78.*Bibio thoracica* Say, 1824, Expd. to St. Peters Riv. vol. 2, 368, 1859, Compl. writ. vol. 1, 250.

These are probably the same species but as Say's type is lost Wiedemann's name is used.

Doctor Max Beier of the Wein Museum kindly made comparative studies of Wiedemann's type so this species can now be accurately placed.

This species is related to *Bibio carolinus* Hardy and the females of these have heretofore been considered one species. The males key out near *longipes* Loew by having the posterior basitarsi swollen but otherwise they are very different from this species. It differs from *carolinus* by having the posterior basitarsi of male swollen (fig. 201c); in both sexes only the posterior portion of humeral ridges are yellow and the mesonotum has three characteristic, broad, finely shagreened areas. The pleurae are more densely pale haired; and the vertex has shorter hairs behind the ocelli in the male; *carolinus* has very elongate hairs on this portion of the head. The sides of scutellum and upper lateral margins of metanotum are ruficent in *carolinus* males, entirely black in *rufithorax*. The females differ markedly in that the length of the head behind the eyes is much shorter than the length of the eyes (fig. 201b) instead of longer than the eye length (fig. 187a), and no tubercles are present in the middle of the face behind the antennae as in *carolinus*. Head and prothorax finely shagreened, giving a dull appearance; entire head and prothorax of *carolinus* brightly polished, chiefly smooth. The propleurae with characteristic vertical striations, somewhat concentrically arranged. The head, propleurae, mesopleurae and sternopleurae more densely pale haired in *rufithorax*, almost bare in *carolinus*. The specimens of both sexes are also larger in size and the male genitalia are very different.

MALE.—In addition to the above characters the males are almost entirely black. *Head*: Compound eyes are divided into an upper and lower portion by a transverse indentation near the lower margins; the pile of the eyes is rather dense and brown in color, that of face chiefly yellow. Antennae nine segmented, the segments rather closely compacted; first segment (scape) is about equal to the third in length, the second (pedicel) is almost two times as long as the scape. *Thorax*: Mesonotum with three broad, dull vittae, brought

about by a shagreened condition of the cuticula; the median vitta extends almost the entire length of the mesonotum, less distinct in front and behind; the lateral vittae are separated from the median by a polished stripe on each side and from the lateral margin by another broader shining stripe. Halteres brownish, with a faint tinge of yellow. *Legs*: Entirely shining black, front tibiae long and slender, equal to femora in length, inner spur much less than one-half the length of the outer (fig. 201d). *Wings*: Brown fumose on anterior margin, yellow on posterior; anterior veins and stigma brown, posterior veins yellow-brown. Crossvein r-m equal in length to the basal portion of vein M_{1+2} , situated well before the branch of M_{3+4} . Cubital vein ending much before the wing margin, anal vein not extending much beyond the base of m-cu crossvein (fig. 201a). Veins in posterior portion of wing, although lighter in color are much thicker than anterior veins. Abdomen rather thickly pale pilose. *Genitalia*: Ninth sternum with a median cleft over one-third its length, and a moundlike gibbosity in the middle of the cleft; sternum broader than long. Harpagones rather short, bent down into a blunt beaklike process apically (fig. 201c). Ninth tergum deeply V-shaped cleft, about two-thirds its length (fig. 201f).

Length of wings, 11-11.4 mm.

Type locality: Pennsylvania.

Type in Vienna Museum.

Specimens have been examined from South Port, North Carolina, April, 1934 (Harris-Wray); Winnabow, N. C., 4-15-1937 (Harris-Wray); Virginia Beach, Virginia, May 17, 1907 (I. J. Condit); it also has been reported from Washington, D. C., South Carolina, Texas and Florida.

Bibio sericatus Hardy

(Plate XL, figs. 202a-b)

Bibio sericata Hardy, 1937, Proc. Utah Acad. Sci. XIV, 207.

This species is related to *longipes* Loew but is easily separated by the pale stigma and almost obsolete posterior veins, by the blunt tibial spurs and shortened subsegments of tarsi. Following is the original description with additional notes on the leg characters:

"*Male*.—Chiefly shining black, except rufous tibial spurs, yellow humeral ridges and sometimes slight tinge of rufous on the tibiae and basitarsi. Pile of eyes black, that of face gray to brown; that of body and legs for the most part yellow, somewhat reddish-yellow on tibiae and tarsi. Inner spurs of front tibiae short, about one-fourth the length of the outer; posterior femora clavate, tibiae hardly

so; segments of posterior tarsi swollen and rather globular; basitarsi conspicuously swollen and more short (not so elongate as *longipes*), being about one and one-half times as long as the next segment. Wings slightly yellow fumose, darker costally; anterior veins dark brown, stigma yellowed, almost obscure; posterior veins concolorous with the membrane, or but slightly more yellowed; crossvein r-m equal to basal part of Rs."

The inner spur of front tibia is blunt, somewhat rounding at its apex, the outer is about as thick as the metatarsus and extends about half its length (fig. 202a). The spurs of hind tibiae are blunt and thick, especially the inner spur; the posterior metatarsus is scarcely over twice as long as wide (fig. 202b).

"*Female*.—The female differs in having only the coxae and trochanters of the legs black, the other joints being yellow to rufous, and in having all pile short, sparse and yellow.

"Length of wing, 4.5-5.5 mm."

This species occurs in the late summer and early fall.

Type locality: Mt. Rainier, Washington.

Type returned to Mr. J. Wilcox, Alhambra, California.

Added distribution: Yahk, Lamb Creek, B. C., Aug. 9, (C. Garrett); Oliver, B. C., Aug. 27 (C. Garrett); Cranbrook, B. C., Sept. 29 (C. Garrett).

Bibio similis James

Bibio similis James, 1936, Amer. Mus. Novit. No. 832, 5.

This species approaches rather closely to *albipennis* Say but is distinguished by the longer r-m crossvein in the wing.

MALE.—Shining black, except for reddish tibial spurs and yellowed bases of metatarsi. Pile of head gray to black, that of body, coxae and femora chiefly pale yellow, a few long, gray hairs on the anterior portion of the abdomen; tibiae and tarsi with short black and pale hairs intermixed. *Legs*: Inner spurs of anterior tibiae short, not over one-fourth the length of the outer; posterior femora and tibiae clavate, posterior basitarsi not swollen, about twice as long as next tarsal subsegments. *Wings*: Whitish hyaline, anterior veins and stigma black, posterior veins somewhat lighter, r-m crossvein almost as long as the basal part of the posterior branch of radius.

Length of wing, 7-8 mm.

Female unknown.

Type locality: Boulder, Colorado.

Type in the American Museum.

James also reports this species from Rifle, Colorado, and Fort

Duchesne, Utah. The writer has identified specimens from Ft. Collins, Colorado; South Fork, Provo Canyon, Utah (Hardy); Logan Canyon, Utah, 5-16-34 (Thatcher); Plain City, Utah, 5-6-35 (G. F. Knowlton) and Logan, Utah, 5-26-33 (Thatcher).

Bibio slossonae Cockerell

Bibio slossonae Cockerell, 1909, Fossil Insects from Colorado. The Entomologist, vol. 42, p. 174. Change of name for *B. gracilis* Walker.

Bibio gracilis Walker, 1848, (nec Unger), List Dipt. Ins. Brit. Mus., vol. 1, 123.

This species is related to *longipes* Loew but is distinguished by the black pile of the male and black dorsum of thorax of female.

MALE.—Head and appendages, thorax (except pale humeral ridges) and abdomen shining black; the legs dark reddish-brown to black, with a few yellowish hairs intermixed on the femora. *Legs*: Inner spurs of front tibiae short, one-third to one-fourth the length of the outer; posterior femora clavate, elongate; posterior basitarsi greatly swollen. *Wings*: Yellow fumose to yellow hyaline; anterior veins and stigma brown, posterior veins more yellowish; r-m cross-vein slightly longer than the basal part of Rs.

Length of wing. 4.7-5.3 mm.

FEMALE.—The female differs in having all hair short and pale; the legs yellow to rufous, slightly darkened apically, and the pleurae usually tinged with rufous.

Type locality: Nova Scotia.

Type in British Museum.

Specimens have been examined from Alberta, British Columbia, California, Colorado, Manitoba, Michigan, Minnesota, Newfoundland, New York, Saskatchewan, South Dakota, Wisconsin and Wyoming.

Bibio tenellus Hardy

Bibio tenella Hardy, 1937, Proc. Utah Acad. Sci. XIV, 208.

This species is related to *pingreensis* James and is distinguished by the dark yellow fumose wings and the reddish-brown apices of femora. Following is the original description:

"*Male*.—Head, body (except pale humeral ridges), coxae and trochanters black; front femora chiefly black with but slight rufous tinge; middle and anterior femora dark reddish-brown on the apical half and slightly yellowed on the basal constriction; middle and hind tibiae and the first two segments of all tarsi yellow, darkened apically; last three tarsal segments dark brown to black; anterior tibiae yellowed basally, dark brown medianly; tibial spurs rufous to yel-

low. Inner spur of front tibiae very short, one-third to one-fourth the length of the outer; posterior femora and tibiae clavate, tibiae slightly thicker than femora; posterior basitarsi distinctly elongate, not noticeably swollen or globular, at least two times as long as the second tarsal segment. Pile of eyes rather short and black, that of the face copious, brown, that of the thorax, abdomen and legs, for the most part, copious, long and yellow; tibiae and tarsi with some darker pile intermixed. Halteres yellow-brown, much lighter in color than thorax. Wings dark yellow-fumose, anterior veins and stigma yellowish-brown, posterior veins yellowed and concolorous with the membrane; r-m crossvein almost equal in length to the basal part of the Rs.

"Length of wing, 6-6.6 mm.

"Female unknown."

Type locality: Healy, Alaska.

Type in United States National Museum.

Bibio townesi n. sp.

(Plate XL, fig. 203a)

This species is related to *fluginatus* Hardy and *inaequalis* Loew. The males are readily distinguished by the bright yellow ninth sternum and harpago bases, yellow coxae and trochanters, sparsely pilose eyes and more hyaline wings. *B. fluginatus* Hardy has the r-m crossvein shorter to about equal to basal portion of vein Rs, crossvein r-m is distinctly longer than base of Rs in *townesi*. The females may be separated from *inaequalis* by their smaller size and smoky yellow wings.

MALE.—Eyes very sparsely covered with short pale pile, lower one-fourth of each compound eye divided off by a transverse depression. Antennae eight segmented, second segment (pedicel) yellowish. Face rather thickly gray pilose. Thorax chiefly shining black with scattered yellow hairs, sometimes the median portion of mesonotum is rufous in ground color. Humeral ridges and posterior margin of pronotum and propleurae pale yellowish. Halteres yellow-brown to black, stems more pale. *Legs*: Almost entirely yellow, apices of tibiae slightly darkened, spurs rufous; apical two to three tarsal subsegments faintly brownish. Inner spurs of front tibiae short, about one-third the length of the outer; outer spurs extend almost half the length of the metatarsi. Spurs of hind tibiae slender and acute. Posterior metatarsi distinctly thickened, about equal in width to the apex of the tibiae; metatarsi about four times as long

as wide and longer than next two subsegments. Femora and tibiae slender, posterior femora average 2 mm. in length, posterior tibiae average 1.7 mm. *Wings*: Hyaline with a faint yellowish tinge, stigma and anterior veins brown, posteriors brownish yellow, darker than membrane. Basal portion of vein Rs, shorter than crossvein r-m. Abdomen mostly shining black, lateral margins of terga often with a faint yellowish tinge. *Hypopygium*: Ninth sternum bright yellow, cleft extending almost half the length of the segment. Harpagones elongate and slender, gently curved downward (fig. 203a); bases yellow, otherwise brown to black. Ninth tergum gently concave on hind margin.

Length: body, 4.2-4.4 mm.; wing, 4.4-4.6 mm.

FEMALE.—Head rufous tinged in ground color, rather thickly covered with yellow hairs. Head behind compound eyes almost twice as long as the eye length. Thorax entirely yellow; posterior metatarsi slender and elongate; wings pale yellowish fumose. The abdomen is entirely yellow-brown with the sterna more distinctly yellowish.

Length: body, 4.4 mm.; wing, 5.5 mm.

Holotype male, Westerly, R. I., July 29, 1937 (N. Chapman). Allotype female, Hancock, N. Y., Aug. 11, 1935 (H. K. Townes). Two paratype males, same data as holotype; one paratype male, Canterbury, Connecticut, July 25, 1937 (N. Chapman) and five paratype males, Lake Mohonk, Ulster Co., N. Y., Aug. 1, 1936 (H. K. Townes).

Holotype, allotype and three paratypes returned to Doctor H. K. Townes, others retained in the Snow Entomological Collection.

Bibio tristis Williston

Bibio tristis Williston, 1893, in Kellogg, V. L., Insect notes, Trans. Kansas Acad. Sci. 113-114.

Related to *xanthopus* Wiedemann but distinguished by the dense black pile on the dorsum of thorax.

MALE.—Head, thorax (except yellowed humeral ridges), abdomen, coxae and trochanters black, with rather copious black pile. *Legs*: Femora, tibiae and tarsi chiefly rufous with dark tips; sometimes apical halves of femora and tibiae somewhat darkened; pile of legs gray to black, that of tibiae and tarsi shorter and darker than that of femora. Hind femora and tibiae clavate, hind basitarsi not swollen, about equal in length to next two subsegments. Inner spurs of front tibiae short, about one-fourth to one-fifth the length of the outer. *Wings*: Dusky hyaline, r-m crossvein almost equal in length

to the basal part of Rs. Anterior veins and stigma brown, posteriors brownish yellow.

FEMALE.—According to Williston the female has the pile chiefly black and has the middle and hind coxae in part black. It will probably key out near *xanthopus* but since this writer has not examined a female and the original description is rather meager its exact position is unknown.

Type locality: Western Kansas.

Location of type unknown. No specimens of the type series are at the University of Kansas or Kansas State College.

The species has been reported from Kansas and Graham Mts., Arizona. Males apparently belonging here have been examined from Pullman, Washington, 24 April, '01; Wellsville, Utah, 6-3-37 (F. C. Harmston) and Provo, Utah, V-9-37 (D. E. Hardy).

Bibio utahensis Hardy

Bibio utahensis Hardy, 1937, Proc. Utah Acad. Sci. XIV, 208-209.

This species is related to *mickeli* Hardy but is separated by the dark posterior veins and shorter inner spurs of front tibiae. Following is the original description:

"MALE.—Entirely shining black, except for pale humeral ridges and tibial spurs. Pile of the eyes black, that of face gray; of the thorax chiefly black; pile of coxae and femora gray to yellow; that of tibiae and tarsi black; of abdomen gray to black anteriorly, yellow posteriorly. Inner spurs of front tibiae about three-fourths the length of the outer; posterior femora and tibiae slightly clavate, posterior basitarsi not swollen, and rather elongate, as long as next two tarsal segments. Wings chiefly hyaline, slightly dusky anteriorly; anterior veins gray to brown; r-m crossvein one-half to equal the length of the Rs.

"Length of wing, 6-7 mm."

Female unknown.

Type locality: Provo River, Provo, Utah.

Type in Brigham Young University collection at Provo, Utah.

Additional distribution: Utah: Logan Canyon, May 15, 1938 (D. E. Hardy, A. T. Hardy); Richmond, May 13, 1938 (D. E. Hardy); Spanish Fork, May, 1938 (Knowlton, Hardy); Logan, May 8, 1938 (D. E. Hardy); Mantua, May 3, 1937 (G. F. Knowlton); Honeyville, April 29, 1939 (G. F. Knowlton, D. L. Bischoff); Washington: Pullman, May 6, 1899.

Bibio velcidus Hardy

Bibio velcida Hardy, 1937, Proc. Utah Acad. Sci. XIV, 209.

This species is related to *abbreviatus* Loew but is distinguished by having the pile of the body chiefly black and the legs dark reddish brown to black, the male genitalia have not been dissected. Following is the original description:

"MALE.—Head, body (except yellowed humeral ridges), coxae and trochanters shining black. Femora and succeeding leg joints dark reddish brown to black, slightly lighter basally; the constriction of the posterior femora and tibiae dark rufous; basal part of tarsal segments yellow. Spurs of front tibiae rufous, the inner spurs about three-fourths as long as the outer; posterior femora and tibiae clavate; posterior basitarsi not enlarged, not much over one and one-half times as long as the second tarsal segment. Pile chiefly black, long and copious; some yellow pile on the posterior half of the abdomen or sometimes sparsely intermixed on the thorax and femora. Wings slightly yellow fumose, anterior veins and stigma dark brown, posteriors light brown-yellow; crossvein r-m equal in length to the basal part of the Rs.

"Length of wing, 6-7 mm."

Type locality: Low Bush, Ontario.

Type in Canadian National Museum.

Bibio velorum McAtee

Bibio velorum McAtee, 1923, Proc. Ent. Soc. Wash., vol. 25, No. 3, 62.

This species appears somewhat related to *nervosus* Loew and is characterized by the rufous femora and the yellowish fumose wings. The following is the original description:

"Inner spur of front tibiae fairly long but still much shorter than outer; head, body and coxae black, humeral ridges yellowish; wings almost uniformly yellowish fumose; stigma small, blackish.

"Male.—Rather long erect hair on eyes, much longer hair of occiput and top of thorax dark, of sides of thorax, coxae and abdomen pale, grayish. Hind legs elongate, femora and tibiae clavate, metatarsi enlarged, the apices of all joints and whole of last two tarsal joints dark, remaining portions reddish, tibiae and tarsi brownish to black; hair of legs tending to agree in shade with integument from which it springs but that of front legs wholly dark grayish. Length of wing: 8-8.5 mm.

"Female.—Pubescence in general shorter and more bristly than in male but all tibiae and tarsi tend to be darker than the femora, all joints dark-tipped. Length of wing: 10-11 mm."

Type locality: Jefferson, North Carolina.

Type in the United States National Museum.

The writer has studied the type and has identified the species from Grandfather Mt. top, North Carolina, Oct. 8, 1936 (D. L. Wray). Specimens have also been seen that seem to belong here from Pingree Park, Colorado, 9,000 feet, August 19, 1929 (D. A. Wilbur) and Cameron Pass, Colorado, Aug. 21, 1940 (G. F. Knowlton).

Bibio vestitus Walker

Bibio vestita Walker, 1848, List. Dipt. British Mus., pt. 1, p. 122.

The original description does not mention the length of the inner spurs of front tibiae, so the identification of this species can not be positive.

The following description is taken from McAtee:

"Head, body, and legs black, clothed with black hairs, abundant and long over head, body, coxae and femora, shorter on remaining joints of legs; tibiae and tarsal joints rufous with dark tips, the last two joints of tarsi almost or wholly dark; front tibiae reddish brown, the spurs very unequal; wings nearly hyaline, stigma and anterior veins brown, the cells bounded by latter more obscure than remainder of wing, posterior veins almost hyaline. Length of wing, 7 mm."

Type locality: Nova Scotia.

Type in British Museum.

McAtee reports this species from St. John, New Brunswick, June 9, 1901 (W. McIntosh). The author has a male specimen from Mirror Lake, Uintah Mountains, Utah (Hardy) which fits the above description very well.

Bibio xanthopus Wiedemann

(Plate XL, fig. 204a)

Bib (io) xanthopus Wiedemann, 1828, Ausz., Zweifl. Ins., I, 80.

Bibio canadensis Macquart, 1838, Dipt. Exot. i, 129. Questionable synonymy, original description is inadequate.

Bibio scita Walker, 1848, List Dipt. Brit. Mus. Pt. 1, 122. Questionable synonymy based only upon description.

Bibio humeralis Walker, 1848, List Dipt. 1, 121-122. Questionable synonymy based only upon description. See note on *B. macateei* James.

Bibio lugens Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 5, Compl. Work, 214-215. New synonymy based upon study of type No. 12518 in Cambridge Museum.

Bibio obscurus Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 5, Compl. Work, 124. New synonymy based upon study of type in Cambridge Museum.

Bibio marateci James, 1936, Amer. Mus. Nov. 832, 4. New synonymy based upon examination of holotype and allotype in American Museum.

McAtee suggested that *obscurus* Loew was probably the same as *xanthopus*. Examination of the type No. 12521 in the Cambridge Museum of Comparative Zoölogy proved this assumption to be cor-

rect. The type differs from typical *xanthopus* only in having the wings more lightly fumose and the posterior veins not so dark, there are such variations, however, in the fumosity of the wings of this species that this cannot be considered a specific character.

Doctor James states *macateei* "is apparently the species which McAtee refers, with a query, to *humeralis* Walker" as Walker's species is unidentifiable from description he preferred to describe it as new. It is based upon the slightly paled anterior margin of mesonotum of the female, the specific variations through a series of *xanthopus* shows this to be an intergrading factor. This synonymy must therefore include *humeralis* although examination of Walker's type may prove it to be distinct.

Bibio xanthopus is related to *nervosus* Loew but is distinguished by the shorter inner spurs of front tibiae.

MALE.—Head, body (except yellow humeral ridges) and coxae black, femora and succeeding leg joints yellow to rufous with dark tips, the tibial spurs rufous. *Legs*: Inner spurs of front tibiae short, about one-third to one-half the length of outer spurs; outer spurs extending but little over one-third the length of the front metatarsi (fig. 204a). Posterior femora and tibiae slightly clavate, hind metatarsi not swollen, about twice as long as second subsegment of tarsi and five times as long as wide. Apical spurs of hind tibiae slender and acutely pointed. *Wings*: Hyaline to yellow fumose, anterior veins and stigma dark brown, posterior veins more pale. Crossvein r-m about equal to the basal portion of vein Rs.

FEMALE.—Differs in having shorter, all pale pile, wings darker fumose and coxae and pleurae usually in part rufous or tinged with brown.

Length of wing, 5.5-9.5 mm.

Type locality: New York.

Type in Vienna Natural History Museum.

This is an exceedingly variable species and many of its intergrades present rather complex problems. It is widely distributed, having been identified from most all of the states and Canadian provinces, it is one of the most common Bibionidae in the Northern states.

Bibio xanthopus palliatus McAtee

Bibio xanthopus palliatus McAtee, 1921, U. S. N. M., v. 60, Art. 11, p. 16.

Bibio signatus Hardy, 1937 Proc. Utah Acad. Sci. v. XIV, 208. New synonymy based upon study of *xanthopus palliatus* type.

At the time *signatus* was described the writer was only acquainted with the typical forms of *xanthopus* (those having the inner spur of front tibiae short), *signatus* was proposed for that group having the

inner spur about equal to the outer in length. Since then all stages of intergrades between the two have been examined proving that these are not distinct species; examination of McAtee's type established this as a synonym of his subspecies.

This subspecies has caused a great deal of controversy because of the variability of the species. The following is McAtee's discussion of it: "Differs from the typical subspecies in darker colors, more abundant pubescence, and somewhat greater average size. The pleura of the female usually are wholly dark. The male has more abundant, longer, and darker hair, sometimes wholly black. This subspecies bears somewhat the same relation to the eastern race of *xanthopus* that *hirtus* does to *albipennis*.

"Length of wing, 7.5-9.5 mm."

The inner spurs of front tibiae vary from one-third the length of the outer as in typical *xanthopus* to almost as long as the outer as characterize the *signatus* form, this makes it necessary to key this subspecies in two different groups. Specimens are usually dusky winged and have been known as *nervosus* Loew. Mr. P. C. Ting states that the larvae of *xanthopus* and *xanthopus palliatus* are quite different, he informed the writer (and has kindly submitted mounted specimens for study) that the dorsum of the anal segment is heavily sclerotized on specimens of *palliatus* and the spinules are elongate (fig. 119a), while the larvae of *xanthopus* consistently lack the heavy sclerotization on the dorsum of the anal segment and the body spinules have more teeth and their bases are short and broad (fig. 118a).

Type locality: Moscow, Idaho.

Type in the United States National Museum.

This subspecies is very common in the west, having been identified from numerous localities in the following states and provinces: British Columbia, California, Idaho, Nevada, Oregon. Utah and Washington.

SPECIES NOT IDENTIFIABLE, DESCRIPTIONS INADEQUATE

Bibio brunnipes (Fabricius), 1794, Ent. Syst. 4, 250 (Tipula). Described from Newfoundland.

Bibio castanipes Jaennicke, 1867, Neue exotische Dipteren, ab. d. senckenb. naturf. Gesellsch. 6, 317. Described from Illinois.

Bibio orbatus Say, 1823, Journ. Acad. Nat. Sci. Phil. III, 78, 1859. Comp. writings II, 69-70. Described from Pennsylvania and although it is not known just what Say had before him it is certainly not to be confused with *orbatus* of the genus *Philia* and *Philia orbatus*

(Wiedemann), 1826, Ausz. Zweifl. Ins. I. is a synonym of *Bibio orbatus* Say.

Bibio rufipes (Fabricius), 1781, Spec. Insectorum II, 410 (Tipula). Described from Newfoundland.

Bibio striatipes Walker, 1848, List. Dipt. Brit. Mus. I, 122-123. Described from St. Martin Falls, Albany River, Hudson Bay.

Bibiodes Coquillett

Bibiodes Coquillett, 1904, Proc. Ent. Soc. Wash. 6, 171.

The members of this genus are similar in many respects to the *Bibio*, they possess the strongly developed spurs on front tibiae but the inner spurs are always rather weak. The wing venation is very different and the two genera are best distinguished by this character. In *Bibiodes* the third longitudinal vein (the posterior branch of the radius) coalesces with the fourth vein (medius) for a short distance near the middle of the wing obliterating the radio-medial crossvein (fig. 205c). The harpagones of the males are characteristically bilobed and show good specific characters. The species are much smaller than any known *Bibio*, wing length averaging from 3.5-4 mm.

GENOTYPE: *Bibiodes halteralis* Coquillett

KEY TO THE SPECIES OF *Bibiodes*

1. Thickened portion of costal margin extending about half way from stigma to apex of wing; femora conspicuously swollen; antennae shorter.....*femorata* Melander, p. 495
Thickened portion of costal margin extending much more than half way from stigma to apex of wing; legs less robust, antennae longer..... 2
2. Halteres yellow; tarsal joints slender; inner processes of harpagones strongly developed, longer than outer lobes (fig. 207a).....*halteralis* Coquillett, p. 496
Halteres dark, at least apically; tarsal joints somewhat swollen; inner processes not strongly developed, about the same size as outer lobes (fig. 205a), *aestiva* Melander, p. 494

Bibiodes aestiva Melander

(Plate XL, figs. 205a-c)

Bibiodes aestiva Melander, 1912, The Dipterous Genus *Bibiodes*, Bull. Amer. Mus. Nat. Hist., vol. 31, 438.

MALE.—Head and appendages, body, coxae, femora, anterior tibiae and tarsi, excepting tibial spurs, shining black with sparse, rather long pale hair, shorter and somewhat brownish on the tarsi. *Legs:* Anterior tibial spurs rufous, the inner spur much shorter than outer, being less than a fourth as long; tibiae and tarsi of the posterior legs yellowish or rufous to reddish brown, the joints darker apically; the tibiae of the mid-legs sometimes entirely black; posterior tarsi somewhat swollen. Stems of halteres pale, knobs black. *Wings:* Hyaline to slightly yellowish fumose, stigma and anterior veins dark

brown, posterior veins light yellowish brown, costal cell (submarginal) yellowish fumose. *Genitalia*: Pile of genitalia chiefly yellow; ninth sternum broad, posterior margin cleft about one-third the length of the segment, cleft broadly U-shaped. Aedeagus broad and blunt, appearing quite heavily sclerotized. Harpagones developed into two lobes (fig. 205a), the outer (main lobe) rather long and sharply pointed, more heavily sclerotized than the inner; the inner lobe is lighter in color and not so distinctly tapered. The two lobes are very nearly equal in size, although very different in shape. Ninth tergum gently convex on both margins and about twice as broad as long. Cerci with but slightly rounded edges, almost square in shape (fig. 205b).

Length of wing, 3.5-4 mm.

Female unknown.

Type locality: Washington.

Type in American Museum of Natural History.

The species has been identified from Idaho, Montana, Oregon, Wyoming, British Columbia, and Manila, Utah, June 26, 1939 (G. F. Knowlton, F. C. Harmston).

Bibiodes femorata Melander

(Plate XL, figs. 206a-b)

Bibiodes femorata Melander, 1912, Bull. Amer. Mus. Nat. Hist., vol. 31, 338.

MALE.—Shining black or brownish black with long, rather copious, gray to yellow pile; tibial spurs rufous; halteres brownish, stems slighter paler than knobs. Wings hyaline, anterior veins and stigma brown, posterior veins yellow. *Genitalia*: Ninth sternum cleft about one-third its length, gently convex in the central portion of cleft. Harpagones bilobed, with the two lobes unequal in size and shape, the smaller development is situated on the ventral portion of the harpago, is almost horizontal in position, directed inwardly and is somewhat obtuse at apex. The larger lobes are dorsal in position, almost twice the size of the ventral lobes and produced into beaklike points, on inner apices (fig. 206a). Ninth tergum but slightly wider than long, gently concave on posterior margin (fig. 206b)

Length of wing, 3.5 mm.

FEMALE.—Pile chiefly yellow, rather long on dorsum and femora. Body dark brownish to black, the specimen at hand has a distinct brownish tinge. Leg joints pale yellowish, tarsi somewhat more brown, femora distinctly swollen. Anterior veins and stigma pale brown, posterior veins concolorous with the membrane. Halteres yellowish.

This is the first female of the genus that has been observed by the author, and as far as is known none have heretofore been reported.

Type locality: Austin, Texas.

Type in American Museum of Natural History.

The writer has examined topotypic specimens, also specimens from Union City, Tenn. (G. I. Reeves).

Bibiodes halteralis Coquillett

(Plate XL, figs. 207a-b)

Bibiodes halteralis Coquillett, 1904, New North American Diptera, Proc. Ent. Soc. Wash., vol. 6, No. 3, 171.

MALE.—Head and appendages, body (with the exception of yellowed humeral ridges), coxae and femora shining black with pale yellow pile. *Legs*: Tibiae and tarsi of all legs dark rufous to reddish brown, joints darker apically; inner spurs of front tibiae very short, being about one-fifth the length of the outer; posterior tarsi not at all swollen or enlarged. Knobs of halteres yellow, their stems somewhat darker. *Wings*: Chiefly hyaline, anterior veins and stigma brown, posterior veins concolorous with the membrane. *Genitalia*: Pile yellow, more sparse than in *B. aestiva* Melander. Ninth sternum rather deeply cleft on hind margin, slightly concave at the bottom of cleft. The harpagones are strongly developed, the two lobes are very unequal in size and shape. The ventral lobe is much larger than the dorsal, is broad and rather blunt with a distinct longitudinal groove at apex; the ventral lobes are nearly horizontal in position. The dorsal lobes are more slender and acute at apices (fig. 207a). Ninth tergum much broader than long, gently concave on posterior margin (fig. 207b).

Length of wing, 3.5 mm.

Type locality: San Mateo Co., California.

Type in United State National Museum.

The species also has been reported from Los Angeles, California (Coquillett) and Claremont, California (Baker). The author has also examined specimens from Cherry Valley, California, Jan. 11, 1938 (Christenson, Clancy); Dundurn, Saskatchewan, 16-5-1923 (R. M. King), Silvery City, New Mexico, (Kellog), and Phoenix, Arizona, 4-IX-31 (E. M. Painter).

Bibionellus Edwards

Bibionellus Edwards, 1935, Stylops, Roy. Ent. Soc. of London, vol. 4, pt. 1, 19.

Following is the original description of the genus and species:

"Allied to *Bibio*, differing chiefly as follows:—Wings with the costa greatly produced, reaching about half-way from R_3 to M_1 (as

in *Dilophus*; in most *Bibio* the costa ceases abruptly at tip of R_5 , this being the case also in *Bibiodes*). Front tibia in both sexes with a conspicuous blunt tubercle in middle beneath (rather larger in male than in female); front femur with a slight enlargement beneath before the tip, this enlargement bearing a group of microscopic tubercles."

GENOTYPE: *Bibionellus tibialis* Edwards.

Bibionellus tibialis Edwards

Bibionellus tibialis Edwards, 1935, *Stylops*. vol. 4, part 1, 19-20.

"Male.—Head black behind and beneath. Eyes broadly in contact and constructed as usual in this family, but quite bare. Rostrum not at all produced. Antennae yellowish, very short, the flagellum composed of only 5-6 segments; palpi of moderate length, brownish. Thorax shining, with short and very scanty black hair; mesonotum light reddish, scutellum and postnotum blackish, pleurae dark brown. Abdomen shining blackish, with scanty dark hair. Hypopygium differing from the usual type of the genera *Bibio* or *Dilophus*, the styles being ventro-lateral in position, without a conspicuous emargination between them (much as in *Plecia*). Legs blackish-brown, including all coxae. Front tibia with a very long outer apical spine (as in *Bibio*), the inner spur very much shorter. Hind femur slender and cylindrical on basal half, much swollen on apical half; hind tibia slender on basal third but greatly swollen on apical half or more, with two moderately long and slender spurs. Hind tarsi slender, much shorter than tibia. Wings rather smoky, with darker stigma, all veins somewhat darker than membrane, base narrowly whitish. Base of R_s and $r-m$ subequal in length and quite short, less than a quarter as long as R_1 . M_2 and Cu_1 reaching margin. Halteres blackish.

"Wing-length 3.5-4 mm.

"Female. Differs from male in having the head, thorax, coxae, femora and tibiae wholly yellowish. Eyes quite small."

Type locality: Bolivia, Yungas von Coloico.

Type in British Museum.

Philia Meigen

Philia Meigen, 1800, *Nouv. Class. Mouch.* 20.

Dilophus Meigen, 1803, *Illiger's Mag.* 1, vol. 2, 269.

Acanthocnemis Blanchard, 1852, in *C. Gay Hist. Chile Zool.* v. 7, 355. This name was previously used by Hawle and Corda, 1848, in *Crustacea* and later by Signoret, 1865, in *Geocoridae*.

The names *Philia* and *Dilophus* have been in dispute since 1908 when Hendel pointed out that many of Meigen's 1803 genera were

the same as those described in 1800. The discussion of the status of *Dorilas* vs. *Pipunculus* will also apply to these genera. The original description of *Philia* is unmistakable and Becker had examined the Meigen types and declared the two congeneric.

The genus *Philia*, in North America, is characterized by the presence of two to three sets of strong spines on the front tibiae. The members of the genus are comparatively small and represent but slight range in size among the various species. They seldom have a wing length of over 6-6.5 mm. in our North American species. The female of several species are inseparable unless accompanied by the male and it is very desirable, and in some cases a necessity, to have both sexes present in order that an accurate identification may be made. Such species as *tingi* n. sp., *spinipes* Say, *orbata*, O. S., *stigmatera* Say, *serotina* Loew, and *arizonaensis* Hardy may be readily identified without dissection of the male genitalia, but in most other species it is essential that these structures be examined. The subcostal vein is weak and the first four radial veins are apparently fused in the anterior branch of radius, the posterior branch (R_5) is simple. The basal portion of R_5 is short compared to the r-m crossvein, being scarcely one-third its length. The posterior veins of wing are usually brownish in color while the anteriors are concolorous with the membrane. The costa extends almost half the distance from R_5 to M_1 in most species.

GENOTYPE: *Tipula febrilis* Linnaeus.

KEY TO THE SPECIES OF MALE *Philia*

1. Front tibiae each with three series of spines (fig. 219a)..... 2
Front tibiae with only two series of spines..... 3
2. Costa extending but a short way beyond end of vein R_5 ; top series of tibial spines with two teeth, middle set with three teeth; entirely black species.
tingi n. sp., p. 513
Costa extending half the distance between tips of vein R_5 and M_1 ; top series with three teeth, middle set with four; dorsum of thorax chiefly rufous...*spinipes* (Say), p. 510
3. Wings dusky to black*serotina* (Loew), p. 509
Wings chiefly hyaline 4
4. Rostrum (the sclerotized portion of the face below the eyes) produced nearly, or distinctly, as long as the antennae 4a *stigmatera* (Say), p. 511
Rostrum distinctly shorter than the antennae..... 5
4a. Veins of costal margin brown; female dorsum rufous.
stigmatera stigmatera (Say), p. 511
Veins of costal margin and stigma almost obsolete, dorsum of female black.
stigmatera nigra Hardy, p. 511
5. Legs chiefly yellow or pale rufous*arizonaensis* Hardy, p. 500
Legs chiefly dark brown to black, coxae never yellow..... 6
6. Pile of the legs and body dark, harpagones each with a broad inner, lateral development (fig. 212a)*orbata* (Osten Sacken), p. 507
Pile of the legs and body pale..... 7
7. Posterior margin of ninth tergum straight or nearly so..... 8
Posterior margin of ninth tergum decidedly concave or emarginate..... 11
8. Harpagones broadly flat-topped from lateral view (fig. 211b), *oklahomensis* Hardy, p. 506
Harpagones not as above 9

- 9 Ninth tergum about as long ~~off~~ median line as across hind margin (fig 208d), cleft of ninth sternum about one-third the length of the segment stigma obsolete
9a *breviceps* (Loew), p 501
Ninth tergum distinctly broader than long 10
9a Dorsum of female thorax yellow to rufous *breviceps breviceps* (Loew), p 501
Dorsum of female chiefly black, only humeri rufous, *breviceps atelates* Hardy p 502
- 10 Cleft of ninth sternum broad and shallow, not over one-fourth the length of the segment, ninth tergum not much wider than long stigma faint or obsolete
tibialis (Loew), p 512
Cleft of ninth sternum about half the length of the segment ninth tergum conspicuously wider than long, three to four times as wide, stigma distinct
proxima (McAtee), p 508
- 11 Cleft of sternum less than one-third the length of the segment, harpagones not greatly thickened apically thorax of female chiefly rufous 12
Cleft of sternum at least one-third the length of the segment, harpagones usually conspicuously thickened apically, narrowed basally 13
- 12 Cleft of sternum about one-fourth the length of the segment, harpagones appearing sharply pointed from ventral view, broadly flat-topped from lateral view (some atypical specimens may run here) *oklahomensis* Hardy, p 506
Cleft of sternum usually about one-third the length of the segment harpagones with rather distinct beaklike apices, not square-topped from lateral view
strigilata (McAtee), p 512
- 13 Cleft of sternum reaching nearly to the base of segment *secta* (McAtee), p 508
Cleft not over one-half the length of the segment 14
- 14 Ninth tergum conspicuously angulate emarginate, (fig 210a), *emarginata* (McAtee), p 503
Ninth tergum gently to decidedly concave, not with a V-shaped cleft 15
- 15 Ninth tergum not much wider than long, cleft of ninth sternum sometimes expanding at the bottom 16
Ninth tergum about two times as wide as long, posterior veins and stigma concolorous with membrane or nearly so *obesula* (Loew), p 505
- 16 Stigma present, cleft of ninth sternum usually expanding basally (fig 209a), apex of each harpago with a notch beneath tergum gently concave on hind margin
caurina (McAtee), p 502
Stigma obsolete cleft of sternum narrowed basally usually expanding at the top tergum more distinctly concave *jamesi* Hardy, p 504

KEY TO THE FEMALE *Phila*

- 1 Front tibiae with three series of spines (fig 219a) 2
Front tibiae with only two series of spines 3
- 2 Costa extending but a short distance beyond end of vein R_5 top series of tibial spines with two teeth, middle set with three thorax black *tingi* n sp, p 513
Costa extending half way between tips of veins R_5 and M_1 top series with three teeth, middle set with four thorax entirely rufous *spinipes* (Say), p 510
- 3 Wings dark 4
Wings chiefly hyaline 5
- 4 Thorax, coxae, and femora rufous *serotina* (Loew), p 509
Thorax black, legs dark reddish brown to black *orbata* (Osten Sacken), p 507
- 5 Rostrum (sclerotized portion of the face below eyes) produced, nearly or distinctly as long as the antennae 5a *stigmatera* (Say), p 511
Rostrum not produced, distinctly shorter than the antennae 6
5a Dorsum of thorax rufous *stigmatera stigmatera* (Say), p 511
Dorsum of thorax chiefly black *stigmatera nigra* Hardy, p 511
- 6 Thorax chiefly rufous above 7
Thorax chiefly black, never more than humeri rufous 10
- 7 All tibiae yellow, concolorous with femora *arizonaensis* Hardy, p 500
All tibiae dark reddish to brown, darker than femora 8
- 8 Teeth of prothoracic comb broad and blunt, comb comprised of seven to ten teeth, v comb very prominent, higher than the eye height *strigilata* (McAtee), p. 512
Teeth of comb not so well developed and more numerous, smaller and more acute, usually twelve to sixteen teeth, (rarely 9-10) comb not so prominent 9

9. Pleurae entirely rufous or yellow, middle comb of front tibiae with large broad teeth *oklahomensis* Hardy, p. 506
Pleurae usually with dark markings, teeth of middle comb not so well developed. *breviceps* (Loew), p. 501
10. Legs entirely black except for yellowish front coxae.....*fulvicoxa* (Walker), p. 503
More of legs yellow to rufous..... 11
11. Middle and hind femora dark*emarginata* (McAtee), p. 503
All femora pale 12
12. Middle and hind tibiae and tarsi pale.....*proxima* (McAtee), p. 508
Middle and hind tibiae and tarsi dark..... 13
13. Humeri dark brown to black.....*jamesi* Hardy, p. 504
Humeri rufous....*obesula* (Loew), *secta* (McAtee), *tibialis* (Loew), *caurina* (McAtee),
breviceps atelestes Hardy

Philia arizonaensis Hardy

Philia arizonaensis Hardy, 1937, Proc. Utah Acad. Sci. Vol. XIV, 209-210.

Following is the original description:

"*Male*.—The male of this species is very distinctive in having the coxae, trochanters, femora and tibiae (except reddish brown front tibiae) pale yellow to rufous; tarsi brown. Eyes light brown with very short, sparse, dark pile, face with yellow-gray pile. First two segments of antennae, basal joints of palpi, and oral margin yellowish, other segments of antennae and palpi brown to black. Dorsum of thorax chiefly black, humeral ridges and posterior margin of dorsum tinged with yellow; pleurae dark with rufous markings; abdomen fuscous. Knobs of halteres dark yellow, stems pale. Wings slightly yellow fumose, costal cell deeply yellow fumose; anterior veins brown, stigma yellow brown, posterior veins but slightly yellowed. *Male Genitalia*: Genital cleft (ninth sternum) shallow, not over one-fifth to one-fourth the length of the segment. Stylus (clasper) rather narrow, not broadly tipped. Superior plate (ninth tergum) gently concave on the posterior margin, slightly wider than long. Pile of genitalia sparse and yellow.

"*Female*.—The female differs in having the thorax entirely yellow to rufous, abdomen lighter, reddish brown and the wings more yellow fumose.

"Length of wing, 3-4 mm."

Type locality: Huachuca Mts., Arizona.

Type in United States National Museum.

The writer has seen additional specimens from the type locality, Aug. 18, 1938 (R. H. Beamer) also from Tajique, New Mexico, June 25, 1940 (R. H. Beamer, D. E. Hardy) and Austin, Nev., Aug. 12, 1940 (D. E. Hardy).

Philia breviceps (Loew)

(Plate XL, figs. 208a-d)

Dilophus breviceps Loew, 1859, Dipt. Amer. Sept. indig., Cent. 9, No. 50, Compl. Works, vol. 2, p. 200.*Dilophus occipitalis* Coquillett, 1904, Invert. Pacifica I, 20.

D. occipitalis is based upon the female sex. The writer has examined the type at the United States National Museum and it appears to be the same as *breviceps* Loew.

MALE.—Shining black, legs sometimes with a brownish tinge. Pile of eyes very short and dark, that of face longer, gray; thorax almost devoid of pile, except for two rows of dorso-central hairs; pile of coxae and femora long, yellow, that of tarsi and tibiae yellow to gray. Anterior thoracic comb usually with twelve to fourteen acutely pointed teeth. Knobs of halteres fuscous, stems paler. Wings hyaline, anterior veins yellow to yellow-brown, stigma usually obsolete, posterior veins entirely concolorous with the membrane. *Genitalia*: Ninth sternum moderately narrow, not broadly expanded; genital cleft about one-third the length of the segment and narrowing slightly basally (fig. 208a). Harpagones somewhat thickened apically, bluntly pointed and rather flat topped from lateral view (fig. 208c). Ninth tergum about as long as wide on median line, anterior margin but gently concave, almost straight (fig. 208d). Pile of the genitalia sparse and pale.

FEMALE.—Pile yellow; head black; dorsum of thorax (except area of thoracic combs), anterior coxae and all femora yellow to rufous. Middle and hind coxae, tibiae and tarsi dark rufous to brown; pleurae with brown to black markings; abdomen deep brown to sordid yellow; the sterna being slightly lighter than the terga. Prothoracic comb with twelve to eighteen teeth, shorter than the eye height; knobs of halteres fuscous, stems pale. Wings yellow fumose, anterior veins and large stigma yellow-brown to dark brown; posterior veins slightly darker than the membrane.

Length of wing, 3.5-4.5 mm.

Type locality: New Hampshire.

Type in Cambridge Museum of Comparative Zoölogy.

The species has been identified from Alabama, Illinois, Louisiana, Mississippi, North Carolina, Ohio, Oregon, Quebec and Wisconsin. It has also been reported from Ontario and New York.

Philia breviceps var. *atelestes* Hardy

Philia breviceps var. *atelestes* Hardy, 1937, Proc. Utah Acad. Sci., vol. XIV, 210.

The females of this variety have the dorsum of thorax entirely black except for the rufous humeri, the abdomen is dark brown to black. Legs and pleurae of the males are for the most part lighter in color than typical *breviceps*, usually being distinctly reddish in ground color.

Type locality: Meach Lake, Quebec.

Philia caurina (McAtee)

(Plate XL, figs. 209a-c)

Dilophus caurinus McAtee, 1921, Notes on Nearctic Bibionid Flies, Proc. U. S. Nat. Mus. vol. 60, p. 19.

The following is the original description:

Male.—Entirely shining or subshining black, eyes with copious long dark hair, hair of other parts of body and of coxae and femora long, pale; of tibiae and tarsi shorter, more bristly, tending to be darker especially on tarsi; genital segments cleft about half its length, the cleft often distinctly expanded at bottom, superior plate only about three times as long as wide along hind margin which is slightly concave; wing grayish hyaline, veins near costa and large stigma pale brown.

Female.—Head and thorax black, abdomen brown, with pale hairs; humeri, front (sometimes all) coxae, and femora yellow to rufous with pale hair, tibiae and tarsi brownish to black, color of hair corresponding to depth of coloring of joints; halteres with pale stalks and dark knobs; wings clear to yellowish hyaline, sometimes with transverse dusky clouding at level of stigma, veins near costa and stigma brownish, others nearly hyaline.

"Length of wing, 4.5-6 mm."

Upon dissecting the genitalia from a paratype male of *caurina* the writer finds that McAtee has misinterpreted the width and length of the ninth tergum as well as the depth of the cleft of ninth sternum. The following corrections and additions should be made to his description: Cleft of ninth sternum (genital cleft) slightly over one-third the length of the segment, cleft expanding basally, narrowed apically (fig. 209a). Harpagones with well developed heads, narrowing basally; apices of claspers thickened, apical portions pointed underneath, and with a ridge or tooth under the point (fig. 209b). Ninth tergum (superior plate) slightly wider than long, posterior margin gently concave (fig. 209c).

Type locality: Popoff Island, Alaska.

The author has examined the type series at the United States National Museum.

It is very common and widely distributed, especially throughout northern United States and Canada. Specimens have been examined from British Columbia, Michigan, New Mexico, Ohio, Utah and Washington.

Philia emarginata (McAtee)

(Plate XL, figs 210a-b)

Dilophus emarginatus McAtee, 1921, Proc. U. S. Nat. Mus., 60, 29

Following is the original description with added notes on the male genitalia:

“Male.—Body shining black, legs more brownish, the front tibiae darker; close-set hair of eyes dark, longer hair of underside of head, body and greater part of legs pale, of front tibiae and tarsi dark; genital segment with a cleft half its length, rounded expanded at the bottom, superior plate decidedly not transverse, about as long as wide across hind margin which is distinctly angularly emarginate; wings hyaline, veins near costa brown, stigma nearly obsolete.

“Female.—Humeri obscurely castaneous, thorax otherwise, and head shining black, abdomen velvety brownish black; legs rufous more or less suffused with brown, the front coxae and femora palest; all hairs pale; wings hyaline, veins near costa distinct, stigma brown.

“Length of wing, 4.5 mm.”

The cleft of ninth sternum does not extend quite half the length of the segment (fig. 210b) and the bottom of the cleft is slightly convex. Harpagones simple, slightly enlarged apically and each with a small indentation just below apex. The cleft of ninth tergum (superior plate) extends about one-fourth the length of the plate (fig. 210a).

Type locality: Samoa, California.

The author has examined the type and allotype at the United States National Museum, also one male topotype specimen, same data and in the same collection as the type. This was evidently overlooked by the author of the species.

Philia fulvicora (Walker)

Dilophus fulvicora Walker, 1848, List of Dipt. Brit. Mus. I, 117

The writer does not know this species. It is based upon a female specimen which appears to be distinctive in having the legs chiefly black. The following is the original description:

"Niger, thoracis dorso serrato, coxis anticis fulvis, alis limpidis, fusco unimaculatis.

"Body black, shining; eyes red: feelers black: a toothed ridge along the chest: abdomen dull black: legs black; fore hips tawny: wings colourless; a large, irregular, light brown spot under the brand, which is dark brown; fore border veins piceous; the other veins tawny; poisers piceous. Length of the body 2 lines; of the wings 5 lines."

Type locality: St. Martins Falls, Albany River, Hudson's Bay.
Type in British Museum.

Philia jamesi Hardy

Philia jamesi Hardy, 1937, Proc. Utah Acad. Sci. XIV, 210-211.

Species somewhat related to *tibialis* (Loew) but is distinguished by the concave posterior margin of the ninth tergum and the more deeply cleft ninth sternum. Following is the original description:

"*Male*.— Male shining black; eyes with dark hair, that of face yellow-gray; pile of dorsum dark gray to brown (sometimes chiefly yellow), that of pleurae, abdomen, coxae and femora yellow to reddish, of tibiae and tarsi yellow to brown. Knobs of halteres black, stems yellowish. Wings hyaline, anterior veins yellow to yellow-brown, stigma and posterior veins concolorous with the membrane, obsolete. *Male Genitalia*: Superior plate (ninth tergum) rather deeply and evenly convex, cerci rather large and chiefly membranous. Tenth tergite represented by a small slightly chitinized area on the membrane. Genitalia for the most part light haired (some darker hair on the 9th sternite) and with fine yellowish pubescence. The inner edges of the genital cleft being densely yellowish white pubescence. Genital cleft (ninth sternum) slightly convex centrally, and narrowed basally, usually expanded at the top. Coxite rounding apically with dense, fine, pale hair on the inner edges and longer and darker hair on the apices. Stylus (harpago) pointed, point appearing somewhat flattened on the dorsal view of the genitalia.

"*Female*.—The female differs in having the coxae, and femora rufous and tibiae and tarsi brownish red; humeri dark reddish-brown to black. Abdomen fuscous to black; wings slightly yellowish, anterior veins and stigma dark brown, posteriors concolorous with the membrane.

"Length of wing, 4-5 mm."

Type locality: Masonville, Colorado.

Type returned to Colorado State College.

Added distribution: LaSal, Utah, 7-24-40 (G. F. Knowlton, F. C. Harmston); Rondeau Prov. Pk., Kent. Co., Ontario, June 8, 1935 (Steyskal); and Livingston Co., Mich. Hamburg, Aug. 12, 1934 (Geo. Steyskal).

Philia obesula (Loew)

Dilophus obesulus Loew, 1869, Dipt. Amer. Sept. indig., Cent. 9, No. 60, Compl. Work, vol. 1, p. 200.

The following is the description given by McAtee:

"*Male*.—Lower surface of head black with long pale hair, eyes with shorter more abundant dark hair, thorax and abdomen shining black with long, sparse, pale hair; genital segment with a U-shaped cleft about half its length, superior plate transverse, about four times as broad as long, its hind margin slightly concave; legs reddish brown to black, in general pale haired but hairs on tibiae and tarsi (especially the front ones) often in part or wholly dark; wings and veins nearly hyaline, slightly fumose costally, stigma almost obsolete.

"*Female*.—Head black with short pale hair; humeri rufous, thorax elsewhere above shining black with sparse pale hair; pleura brownish-black more or less spotted with paler; abdomen velvety brownish black with abundant pale hair; coxae and femora (and sometimes the front tibiae) yellow to rufous, pale haired; trochanters, tibiae darker haired; wings nearly hyaline, veins near costa brown, rather large stigma nearly black. Females from western localities usually have more or less dusky clouding transversely in the wing at the level of the stigma.

"Length of wing, 4-5 mm.

Upon dissecting the genitalia of specimens identified as *obesula* Loew by McAtee and a large series recognized as this species by the writer it has been found that the length of the ninth tergum (superior plate) has been misinterpreted by the previous workers. This is very easily done because of the normal position of the eighth tergum which usually partially covers the dorsal portion of the ninth. If the genitalia are unrelaxed the true relationship of these segments cannot be determined. The ninth tergum is but slightly over two times as wide as long, instead of four times.

Type locality: District of Columbia.

Type in Cambridge Museum of Comparative Zoölogy.

This is a widely distributed species, McAtee reports it from Maryland, Virginia, Pennsylvania, North Dakota, Colorado, Indiana and

Idaho. The writer adds the following states and provinces: California, Manitoba, Quebec, British Columbia, Ontario and Michigan.

Philia oklahomensis Hardy

(Plate XL, figs. 211a-d)

Philia oklahomensis Hardy, 1937, Proc. Utah Acad. Sci. XIV, 211.

This species is distinguished by the shallow cleft on posterior margin of ninth sternum, the broad flat-topped harpagones of male (fig. 211b) and the entirely rufous thorax and strong development of thoracic combs of the female. Following is the original description:

"*Male*.—Chiefly shining black; humeral ridges yellowed, legs with rufous tinge; stems of halteres yellow, knobs brown. Pile of body short and yellow, that of legs somewhat reddish. Wings (fig. 211c) hyaline, slightly yellow fumose costally; anterior veins brown, stigma pale, usually obsolete; posterior veins concolorous with the membrane. *Male Genitalia*: Coxite comparatively short and broad with a raised area longitudinally down the middle of the pons coxalis; genital cleft (cleft of ninth sternum) rather shallow, being about one-fourth the length of the segment (fig. 211a). Stylus (harpago) appearing pointed from ventral or dorsal view. Posterior margin of superior plate (ninth tergum) gently concave, sometimes appearing straight because of the tenth tergite beneath; (reëxamination shows that the hind margin of ninth tergum is straight, a lighter median area was first interpreted as a concavity); plate slightly wider than long. Cerci larger, pointed apically (fig. 211d). Pile of genitalia short and yellow.

"*Female*.—Differs in having the entire thorax, coxae, trochanters and femora yellow to rufous; tibiae and tarsi dark reddish to brown, and wing yellow fumose.

"Length of wing, 4-4.5 mm."

Type locality: Locust Grove, Oklahoma.

Type returned to Oklahoma A. & M. College.

This species is common in Oklahoma and Texas during March and early April. No fall specimens have been seen so it might have just one generation.

Philia orbata (Osten Sacken)

(Plate XLI, figs. 212a-c)

D. (ilophus) orbatus Osten Sacken, 1859, in Le Conte's edition of The Complete Writings of Thomas Say on the Entomology of North America, vol. 2, p. 70.

This species is related to *stygius* Say, but is readily distinguished from this Mexican species by its much smaller size, shorter rostrum and different arrangement of the median set of teeth on front tibiae.

MALE.—Head, body and legs shining, brownish to black. Pile entirely black, that of hind femora sometimes gray. Compound eyes divided into an upper and lower portion by a transverse indentation near lower margins. Rostrum produced but little over half the length of antennae. Antennae short, segments compacted, eleven segmented with a knoblike tip. Knobs of halteres brown, stems ochraceous. Wings slightly yellowish hyaline, more distinctly yellow costally; anterior veins yellow-brown, stigma dark brown; posterior veins but slightly more yellowed than the membrane, almost concolorous. Front tibiae armed with two sets of teeth, the median set possesses four strong spines in a transverse row. *Genitalia*: Pile of genitalia black, rather dense along the posterior margin of the ninth tergum. Cleft of ninth sternum extends about one-third the length of segment, the middle of the cleft is slightly convex. The harpagones each have a broad inner lateral development (fig. 212a), which is characteristic of the species. The ninth tergum is gently concave and very short, three to four times as wide as long. The cerci are well developed and usually extended. The tenth segment (anal region) is slightly sclerotized on the margins (fig. 212b).

FEMALE.—The female differs in having the wings yellow-brown fumose to dusky black; anterior veins and stigma dark brown, posteriors darker than the membrane. The rostrum is about equal to the length of compound eyes.

Length: body, 3.5-3.8 mm.; wings, 4-4.2 mm.

Type locality: Florida.

Present location of type is unknown.

This species is widely distributed throughout Southeast and Central United States, specimens have been examined from numerous localities in the following states: Alabama, Florida, Georgia, Kansas, Louisiana, Mississippi, North Carolina, Oklahoma (on cotton in Payne Co.), South Carolina and Texas.

Philia proxima (McAtee)

(Plate XLI, figs. 213a-c)

Dilophus proximus McAtee, 1921, Proc. U. S. Nat. Mus. 60, Art. II, 22.

MALE.—Head, body and legs shining black, sometimes faintly reddish black in ground color. Pile of body yellowish, eyes with short brown to black pile. Lower one-third of compound eyes separated off by a transverse groove across the eye. Wings hyaline to somewhat milky, anterior veins and stigma brown, posteriors colorous with the membrane. *Genitalia*: Ninth sternum cleft almost half its length on hind margin, the cleft is slightly convex in the middle (fig. 213a). Harpagones broad and rounded, with a distinct indentation on under sides near apices (fig. 213c) and a longitudinal groove on upper edges. Ninth tergum about three times as wide as long (not four times as in original description), hind margin straight or but very gently concave with the anterior margin somewhat convex (fig. 213b).

Following is the original description of females:

“Female.—Head and thorax except humeri shining black, and abdomen velvety brown, all with short pale hair; humeri and legs chiefly yellow to rufous, tibiae and tarsi, especially of the front legs deeper colored, sometimes black; in pale specimens the trochanters, distal tarsal joints and apices of other tarsal joints only are black, hair of legs except tarsi pale; wings hyaline, veins near costa and stigma brown.

“Length of wing, 3-5 mm.”

Upon dissection of a paratype male of this species it was found that the cleft of ninth sternum (genital cleft) is but slightly over one-third the length of the segment. The harpagones are rather distinctive, having a developed beak at apices.

McAtee reports the species from Colorado, and Hunters Creek, Wyoming. The author has studied the type at the United States National Museum and has seen topotype specimens from Hunters Creek, also specimens from Two-gwo-to-ee Pass, Wyoming, IX-12-95 (W. M. Wheeler).

Philia secta (McAtee)*Dilophus sectus* McAtee, 1921, Proc. U. S. Nat. Mus. vol. 60, Art. 11, p. 22.

The original description is given:

“Male.—Body shining black, legs brownish black; eyes with short, close-set, dark hair; body and legs with longer, sparse pale hair, except on tarsi where it is chiefly dark; genital segment cleft nearly

to its base, superior plate about three times as wide as long, distinctly concave posteriorly; wings hyaline, veins near costa and nearly obsolete stigma yellowish brown.

"Female.—Head shining black, with a few short pale hairs; thorax chiefly shining black, with short, sparse pale hairs, humeri yellowish-rufous and indistinct patches on pleura and scutellum yellowish brown; abdomen velvety brownish-black, with pale hairs; coxae and femora yellowish rufous; trochanters, tibiae and tarsi fuscous to black, those of anterior legs darkest; hair of legs chiefly pale except on tarsi; wings as in male, stigma somewhat more distinct.

"Length of wing, 4.5-5.5 mm."

McAtee reports it from Franconia, New Hampshire, and from White Mts. (Morrison). The author has examined the type at the United States National Museum.

Philia serotina (Loew)

(Plate XLI, figs. 214a-b)

Dilophus serotinus Loew, 1861, Dipt. Amer. Sept., Cent. 1, No. 15, Compl. Work, 9-10

This species is easily recognized by its dusky to black fumose wings and large size.

MALE.—Chiefly shining black. Pile of eyes black, that of face gray, of thorax, coxae, trochanters, femora and posterior half of abdomen yellow to gray; pile of tibiae and tarsi black. Knobs of halteres black, stalks pale. Wings dusky to blackish, darker costally, anterior veins black, posteriors gray. *Genitalia:* Pile of genitalia dense, brownish yellow. Cleft of ninth sternum extending slightly over one-third its length. Inner edges (when viewed from a ventral aspect) of apical portion of ninth sternum with a developed process. Harpagones with a strongly produced beaklike apex (fig. 214a). Ninth tergum gently concave, about as wide as long (fig. 214b).

FEMALE.—The female has the thorax (except black scutellum and some black markings on the pronotum), coxae, trochanters and femora rufous, hind coxae somewhat darker than front. Pile all pale. Wings usually somewhat darker; otherwise like male.

Length of wing, 4.5-8.5 mm.

Type locality: Illinois.

Type in Cambridge Museum of Comparative Zoölogy.

This species has a rather wide range; the writer has examined the type, also material from British Columbia, Kansas, Louisiana, Maryland, Missouri, Oregon, Virginia and Washington. It has also been recorded from Mississippi.

Philia spinipes (Say)

(Plate XLI, figs. 215a-b)

D. (Ilophus) spinipes Say, 1823, Dis. Dipt. U. S., Journ. Acad. Nat. Sci. Phila., vol. 3, 79-80. 1859 Compl. Writings, vol. 2, p. 71.

D. (Ilophus) thoracicus Say, 1823, Des. Dipt. U. S., Journ. Acad. Nat. Sci. Phila., vol. 3, p. 80. 1859 Compl. Writings, vol. 2, pp. 71-72.

Dilophus dimidatus Loew, 1869, Dipt. Amer. Sept. indig., Cent. 8, No. 3, Compl. Work, vol. 2, p. 118.

McAtee states that the variation in size and color of this species sufficiently covers the other two forms which were described having three series of spines on the front tibiae; the types have not been studied so this cannot be verified.

MALE.—Rostrum long, about one-half to three fourths as long as the antennae, extended proboscis longer than the antennae. Lower part of compound eyes and face black, upper part reddish brown. Dorsum of thorax chiefly bright rufous, scutellum and pronotum usually black; pleurae reddish brown with black markings. *Legs:* Front tibiae with three sets of spines, top set with three spines, middle set with four, apical set with eleven or twelve (fig. 215a). Apical spur slightly longer than the spines at apex. Front and middle coxae and femora rufous, remainder of legs brown to black; abdomen velvety black. Pile chiefly black, somewhat gray on the femora. Knobs of halteres black, stem paler. Wings dusky to yellow-brown fumose, darker costally; anterior veins dark brown, posteriors and stigma light brown. *Genitalia.*—Pile of genitalia brown to black. Cleft of ninth sternum extends about one-third the length of the segment (fig. 215b). Harpagones pointed apically, broadened at their bases. Cerci large and rounding. In the specimen dissected the ninth tergum had been torn, McAtee states that this plate is about three times as wide as long with hind margin rounded angulate.

FEMALE.—The female has the thorax entirely rufous (sometimes with a few dark markings on the pronotum and scutellum), the rostrum is in part yellow to rufous and the abdomen velvety brown; otherwise like the male.

Length of wing, 4.5-6 mm.

Type locality: Missouri.

Location of type not known to this writer.

Specimens have been examined from a number of localities in the following states: California, Florida, Indiana, Louisiana, Maryland, Minnesota, Mississippi, Missouri, New Jersey, New York,

North Carolina, Tennessee, and Virginia; also reported from New England.

Philia stigmatara (Say)

(Plate XLI, figs. 216a-b)

D. (Iophus) stigmaterus Say, 1823, Desc. Dipt. U. S., Journ. Acad. Nat. Sci. Phil., vol. 3, pp. 79-80. 1859 Compl. Writings, vol. 2, pp. 70-71.

The species is readily distinguished by the elongate rostrum which is about as long as the antennae; *spinipes* (Say) and *tingi* n. sp. also have the rostrum developed but these species have three series of spines on the front tibiae.

MALE.—Eyes reddish brown with short dark pile; remainder of head and body shining black, with yellow pile; body sometimes with a tinge of rufous. The legs vary from dark rufous to brownish black with rather abundant yellow to reddish hair. Wings hyaline, anterior veins yellow-brown, posteriors concolorous with the membrane; stigma small and almost obsolete. Knobs of halteres dark, stems pale. *Genitalia*: Ninth sternum cleft about one-third its length, harpagones simple and obtuse at apices (fig. 216a). Ninth tergum wider than long, hind margin gently concave (fig. 216b).

FEMALE.—The female differs in having the thorax and legs chiefly yellow to rufous, pronotum, scutellum and pleurae sometimes with dark markings; spines of front tibiae and tips of tarsal joints brown. Abdomen velvety brown, genitalia more or less tipped with yellow. Wings more yellowish fumose, stigma distinct brown.

Length of wing, 3.5-5 mm.

Type locality: Missouri.

Location of type unknown to the writer.

Specimens have been examined from Alberta, Arizona, British Columbia, Colorado, Indiana, Iowa, Michigan, New Mexico, Nova Scotia, Quebec, South Dakota, Utah and Wisconsin.

Philia stigmatara nigra Hardy

Philia stigmaterus var. *nigra* Hardy, 1937, Proc. Utah Acad. Sci. vol. XIV, p. 212.

The females have the dorsum of thorax, except the humeri, chiefly shining black instead of rufous as in the typical *stigmatara*. The anterior veins of the wings of the males are more consistently lighter in color in *nigra*. This is probably best considered a subspecies.

Type locality: Polk Co., Minnesota.

Type in University of Minnesota collection.

Added distribution: The Pas, Manitoba, Aug. 11, 1937 (R. H. Daggy) and Gillam, Manitoba, Aug. 10, 1937 (D. G. Denning).

Philia strigilata (McAtee)

(Plate XLI, figs. 217a-b)

Dilophus strigilatus McAtee, 1921, Proc. U. S. Nat. Mus. vol. 60, Art. 11, pp. 24-25.

The males of this species are somewhat related to *oklahomensis* Hardy but the cleft of ninth sternum is deeper and the harpagones acutely pointed.

MALE.—Shining black (except reddish brown compound eyes), legs sometimes brownish. Pile pale yellow except for the short black pile on the eyes. Knobs of halteres black, stems pale. Wings hyaline, costal cell slightly yellowed; anterior veins concolorous with the membrane. *Genitalia*: Cleft of ninth sternum extends about one third the length of the segment. Harpagones rather thickened but not greatly enlarged apically, terminating in a beak (fig. 217b). Ninth tergum about twice as wide as long on a median line (fig. 217a).

FEMALE.—The female is similar to *breviceps* Loew but differs in having the prothoracic comb more conspicuously developed. The teeth are fewer in number (usually 7-10), longer, more broad and blunt. The female differs from the male in having the thorax, coxae and femora chiefly rufous; pronotum and thoracic comb, pleurae and hind coxae usually marked with black. Wings yellowish to dusky fumose, anterior veins and large stigma dark brown, posteriors slightly more yellowed than membrane.

Length of wing, 4.5-5 mm.

Type locality: California.

Type in the United States National Museum.

The species is common in California and has been identified from numerous localities in that state.

Philia tibialis (Loew)

(Plate XLI, figs. 218a-c)

Dilophus tibialis Loew, 1869, Dipt. Amer. Sept. indig., Cent. 9, No. 61, Compl. Work, vol. 2, p. 200.

This species is recognized by the shallow cleft of ninth segment, the straight hind margin of ninth tergum and the almost obsolete stigma and paler anterior veins.

MALE.—Head and body shining, legs brownish red to black. Pile rather long and chiefly pale, that of eyes, tibiae and tarsi somewhat darker. Wings hyaline, slightly fumose costally; anterior veins brown, stigma almost obsolete; posterior veins concolorous with the membrane. *Genitalia*: Ninth sternum broad, cleft extending less

th: a third the length of the segment. Harpagones rounded apically (fig. 218a). Ninth tergum wider than long, the posterior edge straight or nearly so (fig. 218b). Pile of genitalia pale and very short.

FEMALE.—Female differs in having the humeri, pleurae (in part), coxae and all femora yellow to rufous; middle and hind coxae and all tibiae and tarsi brownish to black. Wings slightly yellowed, stigma distinct.

Length of wing, 4.5-6.5 mm.

Type locality: Sitka, Alaska.

Type in Cambridge Museum of Comparative Zoölogy.

This species is very abundant in the North. Specimens have been examined from numerous localities in the following possessions, states and provinces: Alaska, Alberta, British Columbia, California, Idaho, Manitoba, Michigan, Minnesota, Montana, Ontario, Oregon, Quebec, South Dakota, Utah, Washington and Wisconsin.

Philia tingi n. sp.

(Plate XLI, fig. 219a)

This species is related to *spinipes* (Say) by having three series of toothlike spines on each of the front tibiae. It is readily distinguished by the short costa, the black coloration, the blunt, rounding teeth of thoracic combs, its much smaller size and the shorter head length of the females.

FEMALE.—*Head*: Entirely shining black, rather thickly black haired. The rostrum is produced longer than the antennae and the extended mouthparts reach almost three times the antennal length. Antennae short, the segments compacted, apparently eleven segmented. The segments of the flagellum are so compressed that it is difficult to discern their articulations. The rostrum is shorter than the antennae in *spinipes* and the mouthparts are not so elongated. The compound eyes are longer than the length of head behind the eyes, eyes of *spinipes* much shorter, more rounded. *Thorax*: Shining black, except the faintly reddish thoracic combs. Teeth of thoracic combs short and blunt, anterior comb composed of ten to twelve teeth, comb scarcely divided in the middle. Dorsocentral and marginal hairs long and thin, mesopleurae and sternopleurae with scattered long marginal pile; all thoracic pile yellowish. *Legs*: Largely black, only the front tibiae rufous; front femora and coxae faintly reddish tinged in the median portions; all tibiae and metatarsi with a very faint rufous cast in the black ground color. Front

tibiae with three series of spines (fig. 219a), the top set is situated on the upper third of the segment and contains just two teeth; the middle set is at about the median portion and has three teeth; the third or apical set is made up of eight spines counting the apical spur. All tibial spines are rather broad and blunt, the apical spur is shining black and much larger than the spines at the end of the tibiae. *Philia spinipes* (Say) has three teeth in the top set and four in the median, the spines are more acute and the apical set contains eleven or twelve teeth. *Wings*: Entirely hyaline, anterior veins and stigma brown, posteriors concolorous with the membrane. The costa extends but a short distance beyond the tip of vein R_5 (posterior branch of radius), about one-fifth the distance between tips of R_5 and M_1 ; the costa of *spinipes* half the distance between these veins. The abdomen is blackish brown, the sclerites and conjunctiva of the venter are faintly tinged with yellowish. Cerci black, covered with thick yellow pile.

Length: body and wings, 3.4-3.5 mm.

MALE.—Compound eyes sparsely brown to black haired, lower one-third to one-fourth of each eye is divided off by a transverse depressed area. Rostrum longer than antennae and covered with dense black hair and mouthparts produced as in female. Body and legs entirely black.

Length: body and wings, 3-3.1 mm.

Holotype female, Cronise Lk., San B. Co., Calif., April 28, 1937, No. 300 (P. C. Ting). Allotype male and two paratype females, same data as type. These specimens were collected on the blossoms of *Prosopis*.

The writer takes pleasure in naming this species after Mr. P. C. Ting, State of California, Department of Agriculture, who has contributed much valuable information concerning the immature stages of *Bibionidae*.

Holotype and allotype returned to Mr. Ting, paratypes in Snow Entomological Collection.

The following species are unidentifiable from the original descriptions:

Phila longiceps (Loew), 1861, Dipt. Amer. Sept. indig., Cent. 1, 14, Compl. Work, p. 9. Described from Illinois. This might possibly be *breviceps* (Loew).

Phila pusillus (Wiedemarn), 1828, Ausz. Zweifl. Ins. vol. I, 77. (United States?).

Phila serraticollis Walker, 1848, List Dipt. Brit. Mus., pt. I, 117. Described from St. Martin Falls, Albany River, Hudson Bay.

Plecia bimaculata Walker, 1856, Insecta Saunder. I, 422. United States given as type locality. McAtee states that this may be a *Phila*.

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* n. n. = new name.

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PLATE XXIX

FIG. 110. *Philia orbata* (Osten-Sacken). a. female reproductive system, right ovary, dorsal view; c. o. = common oviduct, ac. gl. = accessory glands, sp = spermathecae.

FIG. 111. *Bibio marci* Linn. (Drawings copied from Morris) a. right mandible of larva; b. right maxilla of larva; c. spicules on cuticula of larva.

FIG. 112. *Bibio lacteipennis* Zett. a. portion of larval cuticula (after Morris).

FIG. 113. *Bibio johannis* Linn. a. larval cuticula (after Morris).

FIG. 114. *Bibio pomonae* Fab. a. larval cuticula (after Morris).

FIG. 115. *Bibio venosus* Mg. a. larval cuticula (after Morris).

FIG. 116. *Philia febrilis* (Linn.) a. larval cuticula (after Morris).

FIG. 117. *Bibio melanopilosus* var. *bisepta* Hardy. a. spicules of larva.

FIG. 118. *Bibio xanthopus* Wiedemann. a. spicules of larva.

FIG. 119. *Bibio xanthopus palliatus* McAtee. a. spicules of larva.

FIG. 120. *Bibio* sp? a. spicules of larva.

FIG. 121. *Hesperinus brevifrons* Walker. a. wing; b. ninth tergum of male; c. lateral view of harpago and distal portion of ninth sternum and tergum; d. harpago, dorsal view; e. left harpago and portion of ninth sternum, ventral.

FIG. 122. *Penthetria appendicula* n.sp. a. male hypopygium, ventral; b. ninth tergum of male, dorsal; c. portion of wing.

FIG. 123. *P. distincta* n.sp. a. ninth tergum of male; b. male hypopygium, ventral.

FIG. 124. *P. heteroptera* (Say). a. male hypopygium, ventral; b. eighth sternum of female; c. ninth tergum of male; d. female genitalia, dorsal.

PLATE XXIX

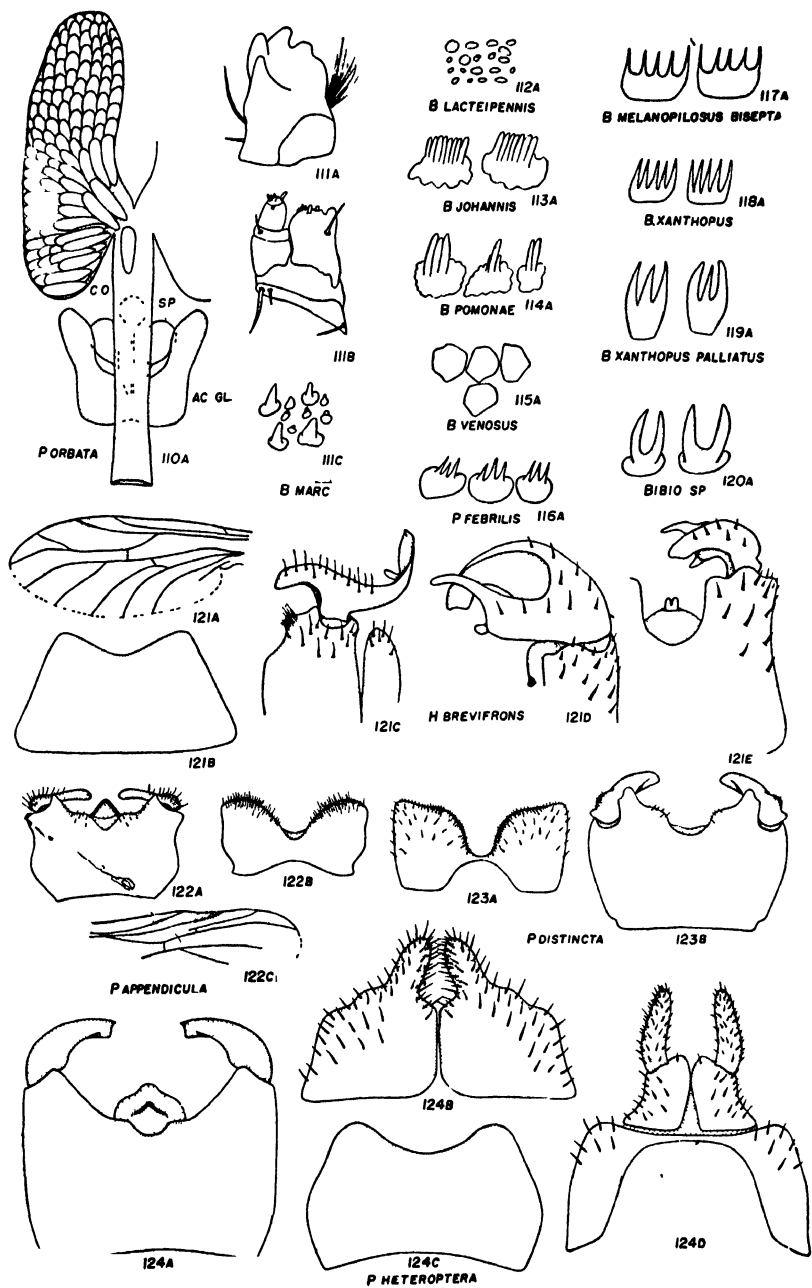


PLATE XXX

FIG. 125. *P. mexicana* (Hardy). a. ninth tergum of male; b. male hypopygium, ventral.

FIG. 126. *P. nigerrima* (Bellardi). a. male genitalia, ventral; b. ninth tergum of male.

FIG. 127. *P. nigrita* Perty. a. male genitalia, ventral; b. ninth tergum of male.

FIG. 128. *Plecia alacris* Curran. a. costal margin of wing; b. male hypopygium, ventral; c. lateral of harpago; d. ninth tergum of male.

FIG. 129. *P. americana* Hardy. a. eighth sternum of female; b. ninth tergum and cerci of female; c. ninth tergum of male; d. male hypopygium, ventral.

FIG. 130. *P. avicephaliforma* Hardy. a. costal margin of wing; b. male hypopygium, ventral; c. harpago, lateral; d. ninth tergum of male.

FIG. 131. *P. biarmata* Hardy, a. ninth tergum of male; b. male hypopygium, ventral.

FIG. 132. *P. bicolor* Bellardi. a. male harpago, lateral; b. male hypopygium, ventral; c. ninth tergum, dorsal; d. ninth tergum and cerci of female; e. female genitalia, ventral.

PLATE XXX

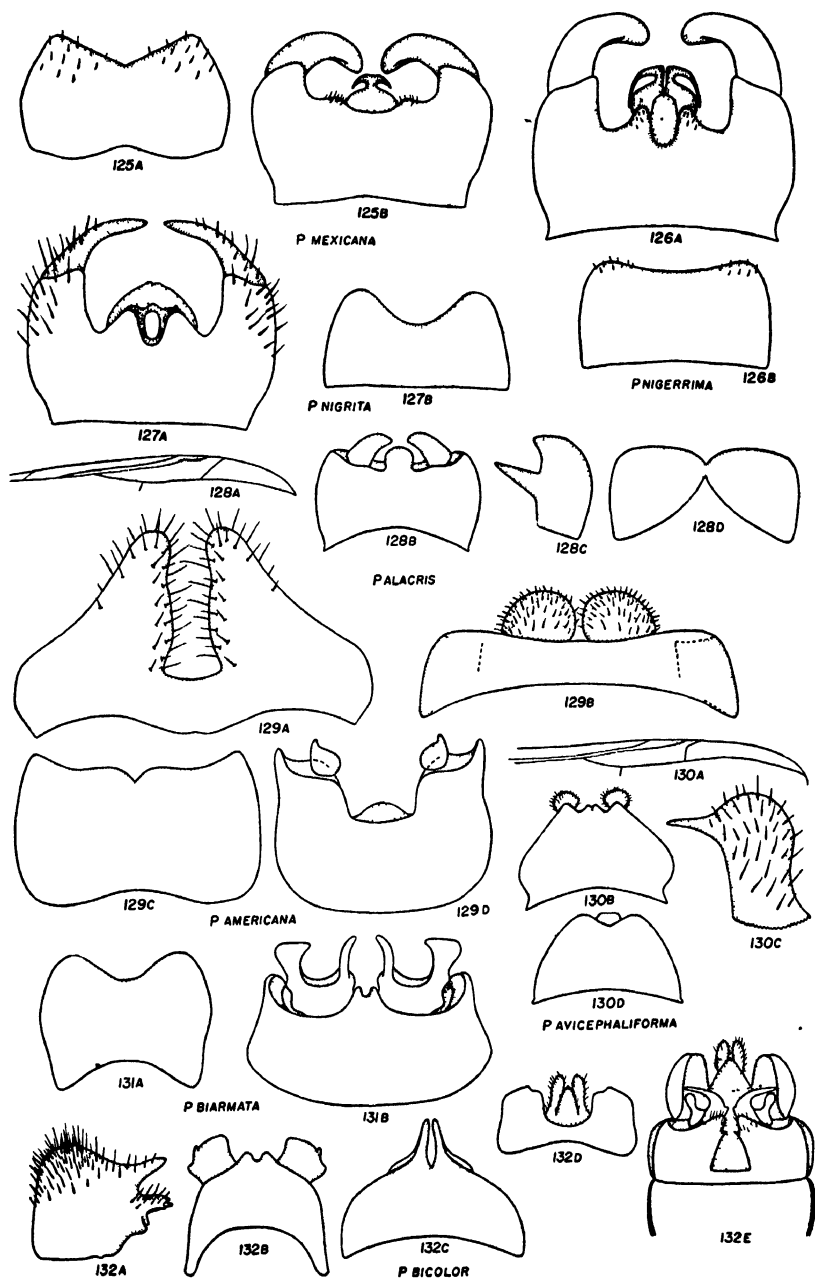


PLATE XXXI

FIG. 133. *P. biformis* Hardy. a. male hypopygium, ventral; b. ninth tergum of male; c. eighth sternum of female; d. female genitalia, dorsal.

FIG. 134. *P. brazilana* Hardy. a. wing; b. male hypopygium, ventral; c. ninth tergum of male.

FIG. 135. *P. collaris* (Fabricius). a. female genitalia, dorsal view; b. female genitalia, ventral; c. harpago, right lateral; d. ninth tergum of male; e. male hypopygium, ventral.

FIG. 136. *P. confusa* Loew. a. male hypopygium, ventral; b. lateral of male harpago; c. ninth tergum and cerci of male; d. costal margin of wing.

FIG. 137. *P. curvistylata* Hardy. a. costal margin of wing; b. harpago, lateral; c. male hypopygium, ventral; d. ninth tergum of male.

FIG. 138. *P. dentata* Hardy. a. costal margin of wing; b. lateral view of harpago; c. male hypopygium, ventral; d. ninth tergum of male.

FIG. 139. *P. disparis* Hardy. a. male hypopygium, ventral; b. ninth tergum of male.

PLATE XXXI

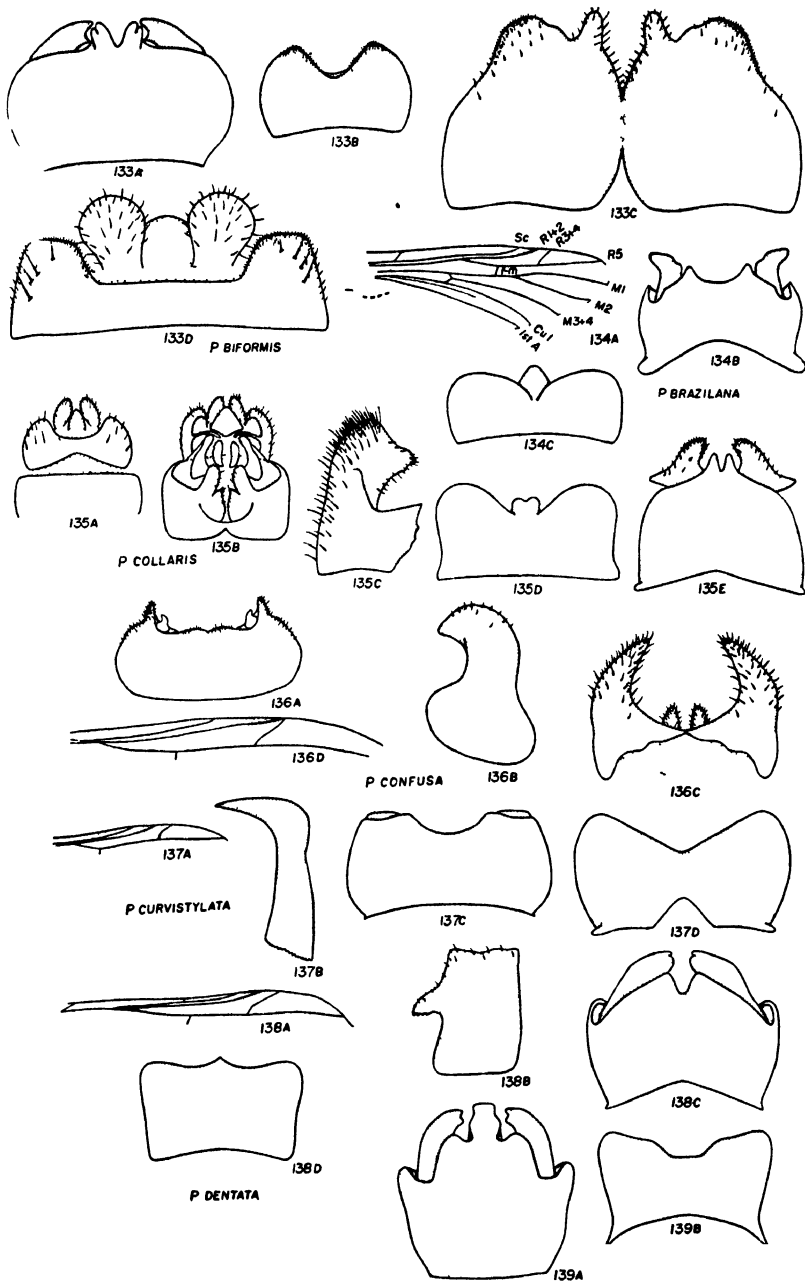


PLATE XXXII

FIG. 140. *P. ecuadorensis* Hardy. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 141. *P. ecuadorensis micans* Hardy. a. eighth tergum of female; b. female genitalia, dorsal.

FIG. 142. *P. edwardsi* Hardy. a. male hypopygium, ventral; b. ninth tergum of male.

FIG. 143. *P. gibbosa* Hardy, a. ninth tergum of female; b. eighth sternum of female; c. ninth tergum of male, and view; d. ninth tergum of male, dorsal; e. ninth sternum and harpagones of male, ventral.

FIG. 144. *Plectu grisea* Edwards. a. ninth sternum and harpagones of male, ventral; b. ninth tergum of male.

FIG. 145. *P. imperialis* Schiner. a. male hypopygium ventral view showing left harpago folded down in natural position; b. ninth tergum of male.

PLATE XXXII

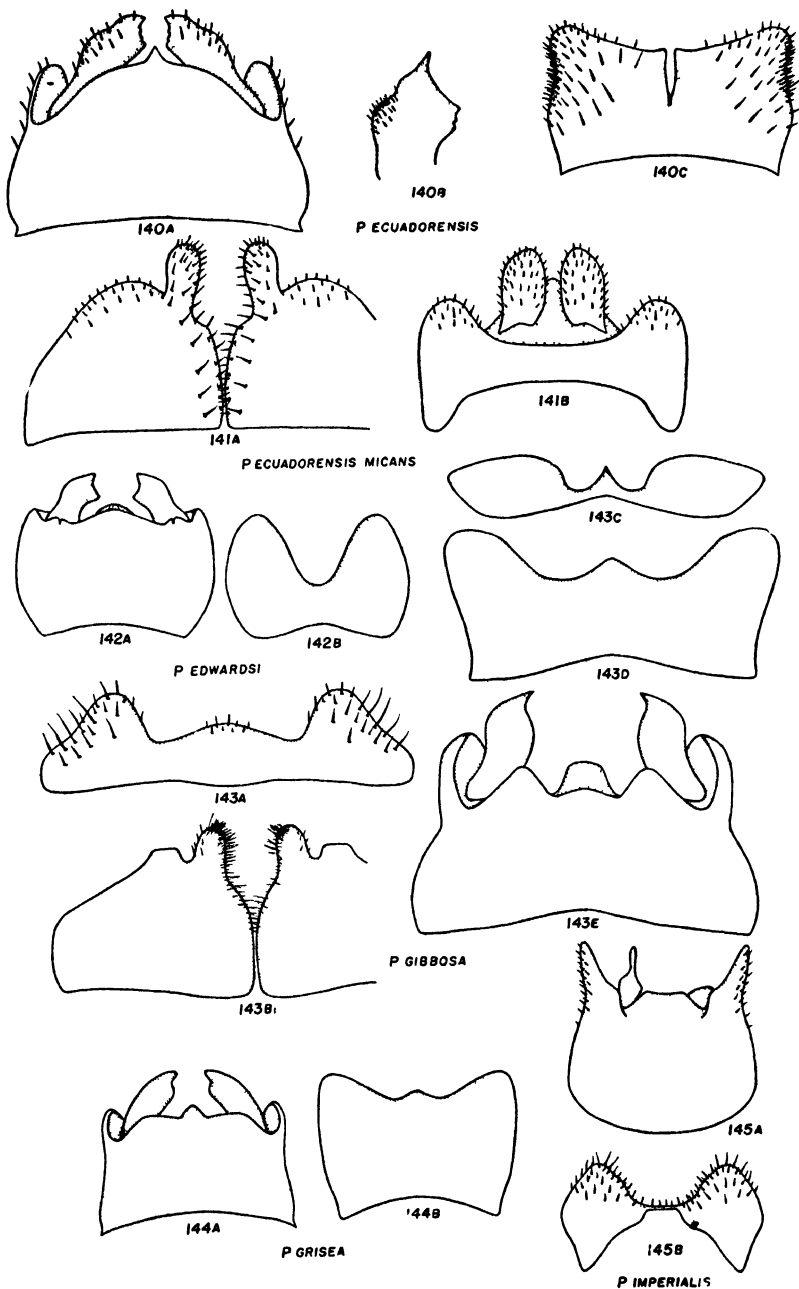


PLATE XXXIII

FIG. 146. *P. impilosa* Hardy. a. hypopygium of male, ventral; b. ninth tergum of male.

FIG. 147. *P. incurvata* Hardy. a. male hypopygium, ventral; b. costal margin of wing; c. ninth tergum of male.

FIG. 148. *P. lateralis* Hardy. a. ninth sternum and harpagones of male, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 149. *P. lindneri* Edwards. a. ninth sternum and harpagones of male, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 150. *P. lopesi* Hardy. a. antenna; b. ninth sternum and harpagones, ventral; c. ninth tergum of male.

FIG. 151. *P. maculata* Hardy. a. male hypopygium, ventral; b. harpago, lateral; c. costal margin of wing; d. ninth tergum of male.

FIG. 152. *P. maura* Walker. a. ninth sternum and harpagones of male, ventral; b. ninth tergum of male; c. eighth sternum of female; d. female genitalia, dorsal.

FIG. 153. *P. nearctica* Hardy. a. ninth tergum of male; b. male hypopygium, ventral; c. male harpago, lateral; d. eighth sternum of female; e. ninth tergum and cerci of female, tergum flattened to show shape. (See also Fig. 153 on Plate XXXIV.)

PLATE XXXIII

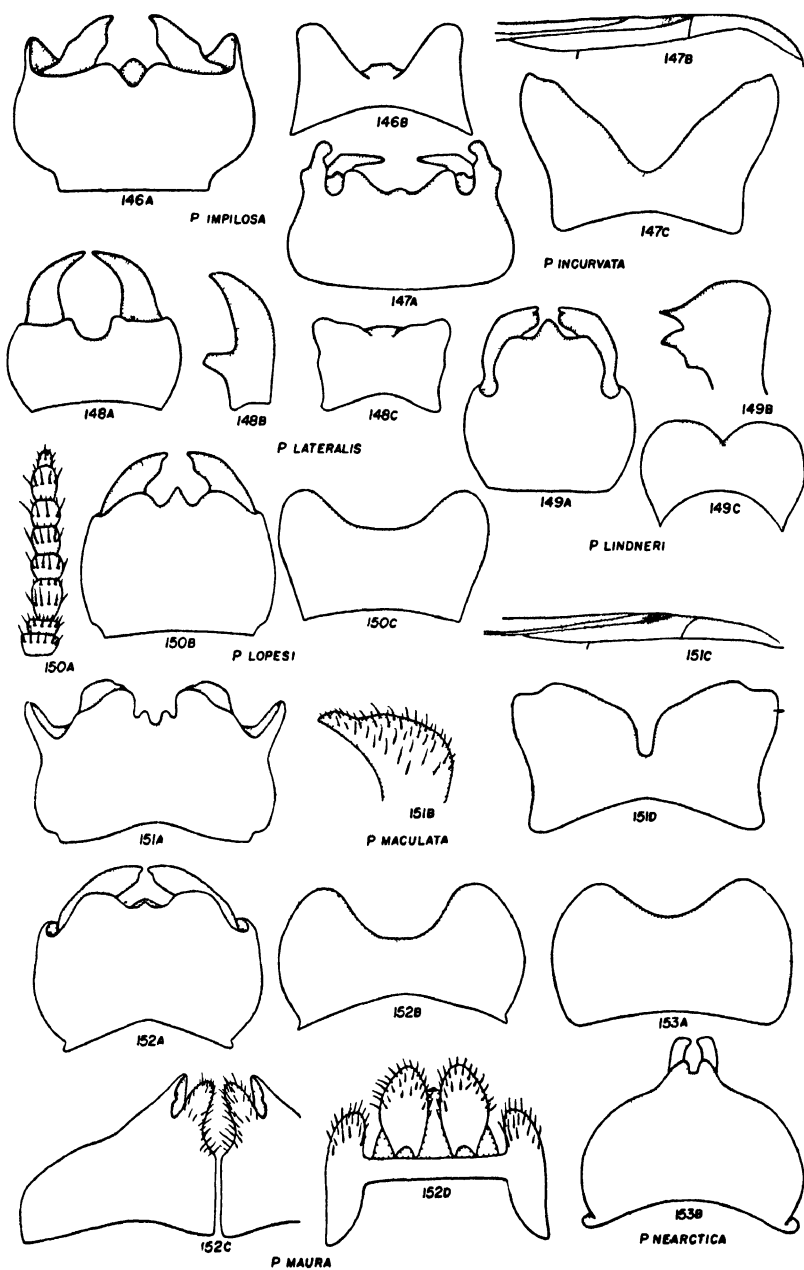


PLATE XXXIV

FIG. 153. *P. nearctica* Hardy. a. ninth tergum of male; b. male hypopygium, ventral; c. male harpago, lateral; d. eighth sternum of female; e. ninth tergum and cerci of female, tergum flattened to show shape. (See also Fig. 153 on Plate XXXIII.)

FIG. 154. *P. nigra* (Philippi). a. costal margin of wing; b. ninth tergum of male; c. ninth sternum and harpagones of male.

FIG. 155. *P. nitidicollis* Edwards. a. ninth tergum of male; b. male hypopygium, ventral; c. harpago, lateral.

FIG. 156. *P. nitidipes* Edwards. a. male hypopygium, ventral; b. ninth tergum of male; c. female genitalia, ventral; d. ninth tergum of female.

FIG. 157. *P. panamaensis* Hardy. a. eighth sternum of female; b. ninth tergum of male; c. male hypopygium, ventral; d. ninth tergum of female.

FIG. 158. *P. parvistylata* Hardy. a. ninth sternum and harpagones of male; b. ninth tergum of male.

FIG. 159. *P. perplexa* Hardy. a. ninth tergum of male, dorsal; b. ninth tergum, end view; c. male hypopygium, ventral; d. male hypopygium, dorsal view with tergum removed.

PLATE XXXIV

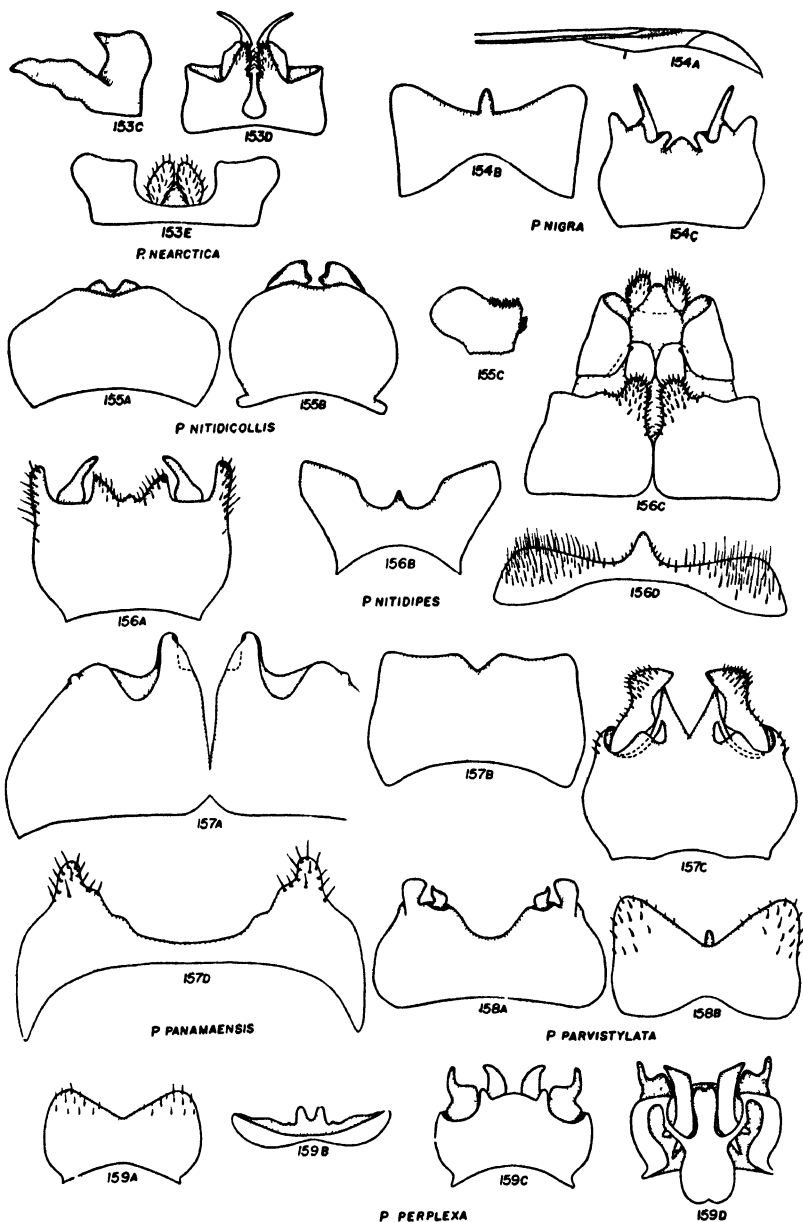


PLATE XXXV

FIG. 160. *P. persimilis* Hardy. a. ninth sternum and harpagones of male; b. harpago, lateral; c. female genitalia, ventral; d. ninth tergum of male; e. ninth tergum of female.

FIG. 161. *P. pertinens* Hardy. a. male hypopygium, ventral; b. ninth tergum of male; c. harpago, lateral; d. female genitalia, ventral; e. costal margin of male wing; f. costal margin of female wing; g. female genitalia, dorsal.

FIG. 162. *P. pictipennis* Edwards. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum and sternum of male; dorsal view showing dorsal extension of sternum.

FIG. 163. *P. plagiata* Wiedemann. a. male hypopygium, ventral; b. ninth tergum of male; c. eighth sternum of female; d. female genitalia, dorsal.

FIG. 164. *P. pruinosa* Hardy. a. male hypopygium, ventral; b. ninth tergum of male. .

FIG. 165. *P. punctulata* Hardy. a. ninth tergum of male; b. male hypopygium, ventral.

PLATE XXXV

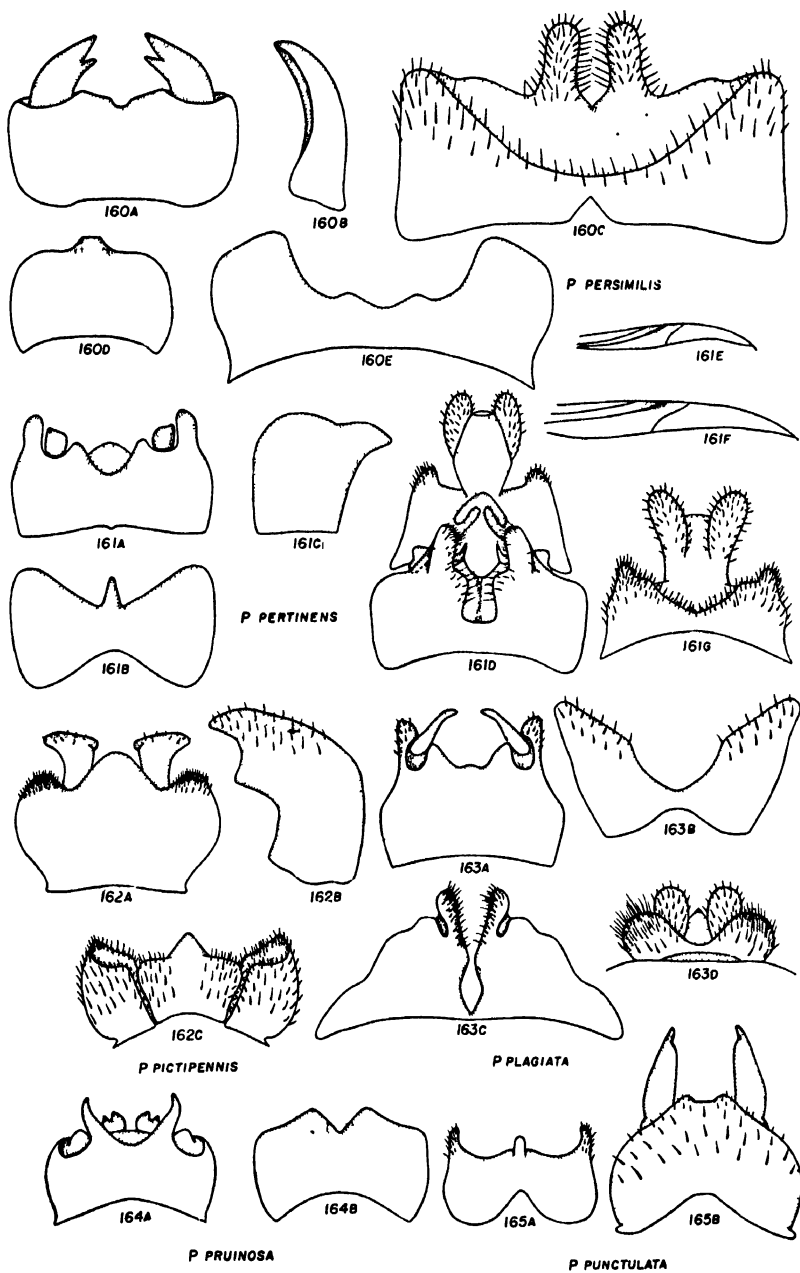


PLATE XXXVI

FIG. 166. *P. quadrivittata* Williston. a. eighth sternum of female; b. male hypopygium, ventral; c. aedeagus and accessory structures; d. ninth tergum of male; e. ninth tergum and cerci of female.

FIG. 167. *P. rectora* Hardy. a. male hypopygium, ventral; b. accessory plate at side of aedeagus; c. ninth tergum of male.

FIG. 168. *P. rostellata* Loew. a. eighth sternum of female; b. ninth tergum of female; c. male hypopygium, ventral; d. ninth tergum of male.

FIG. 169. *P. rufimarginata* Hardy. a. ninth tergum of male; b. male hypopygium, ventral.

FIG. 170. *P. rufiscutella* Hardy. a. ninth tergum of male; b. male hypopygium, ventral.

FIG. 171. *P. rufithorax* Walker. a. ninth tergum of female; b. ninth tergum of male; c. costal margin of wing; d. eighth sternum of female.

PLATE XXXVI

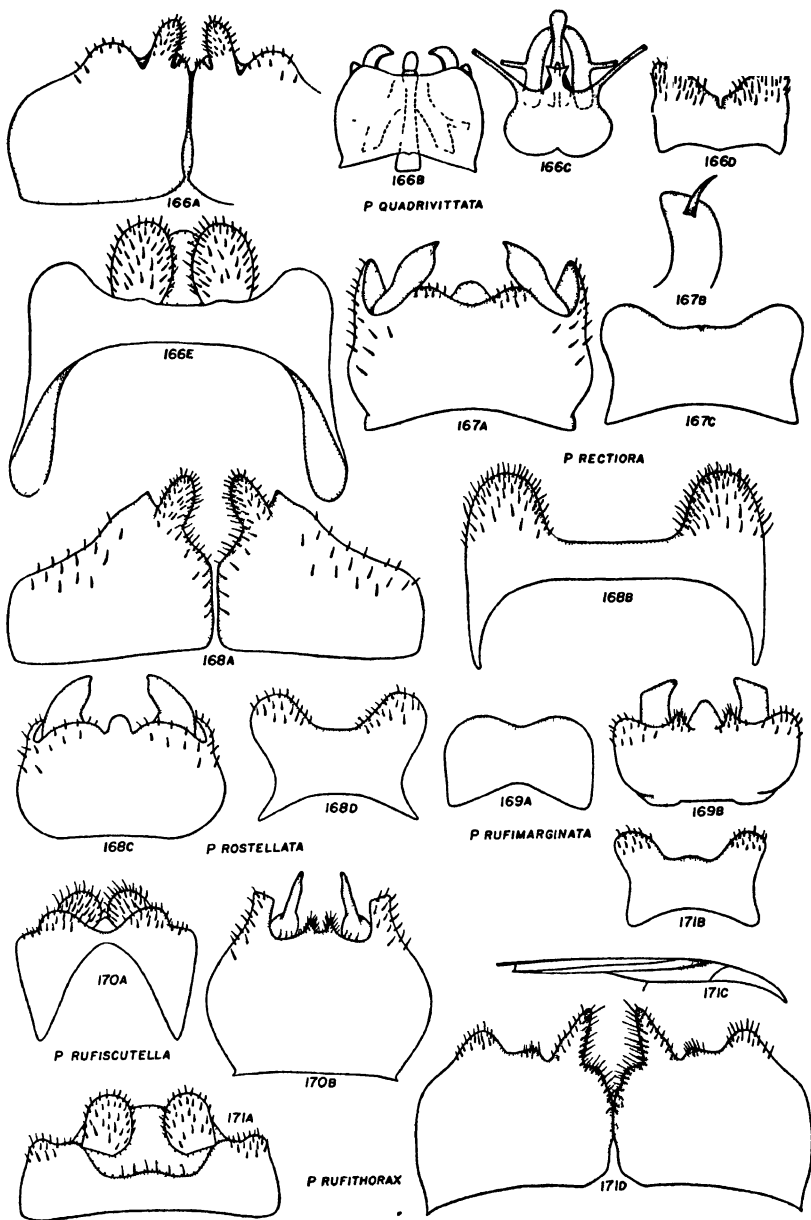


PLATE XXXVII

FIG. 172. *P. rufithorax concava* Hardy. a. male hypopygium, ventral; b-c. variations in appearance of median process of ninth sternum, caused mostly by amount of tilting; d. ninth tergum of male; e. ninth tergum of female; f. eighth sternum of female.

FIG. 173. *P. rugosa* Hardy. a. male genitalia, ventral; b. ninth tergum of male, dorsal; c. ninth tergum, end view.

FIG. 174. *P. seminitens* Edwards. a. male genitalia, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 175. *P. serrata* Hardy. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 176. *P. similis* Rondani. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 177. *P. trilobata* Hardy. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male, dorsal; d. ninth tergum, end view somewhat diagrammatic.

FIG. 178. *P. uberta* Hardy. a. male hypopygium, ventral; b. ninth tergum of male; c. harpago, lateral; d. ninth tergum of female; e. eighth sternum of female.

PLATE XXXVII

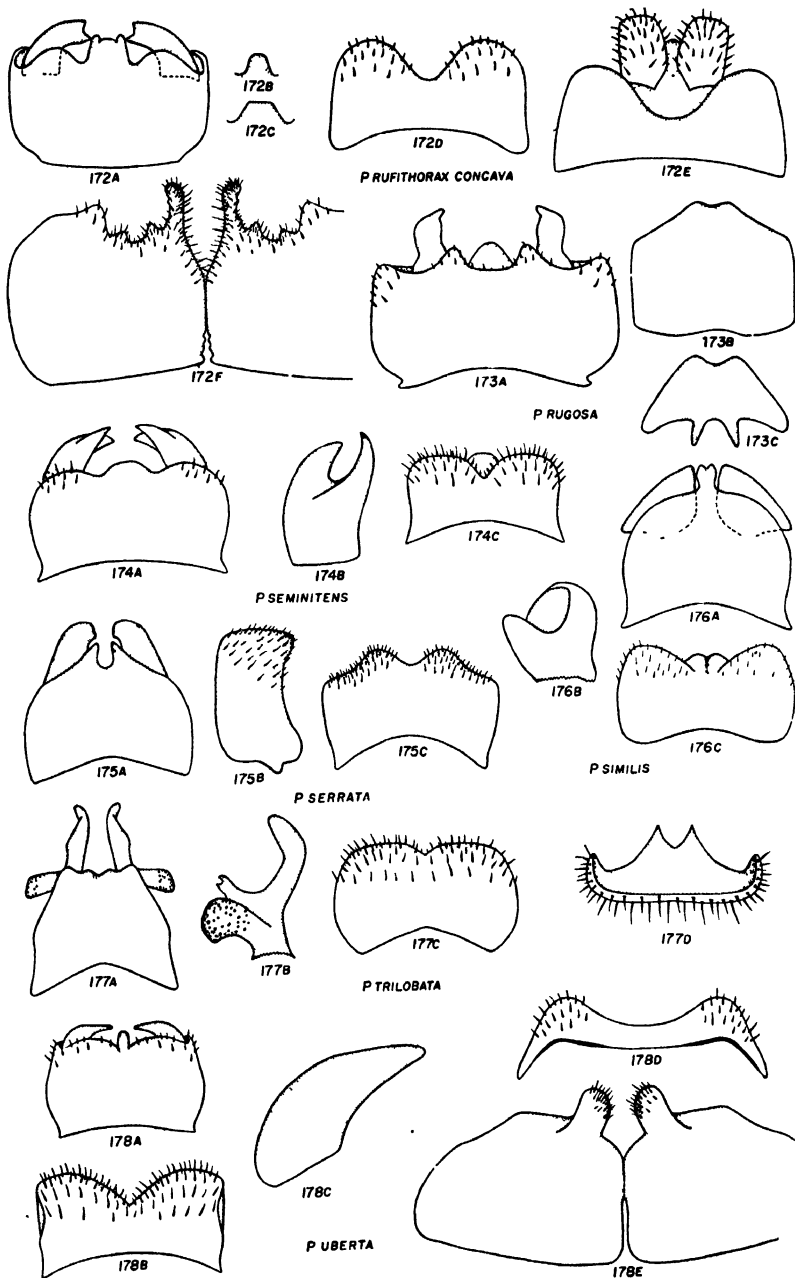


PLATE XXXVIII

FIG. 179. *P. variabilis* Hardy. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 180. *P. vittata* Wiedemann. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 181. *P. xenia* Hardy. a. ninth tergum of female; b. ninth tergum of male; c. harpago, lateral; d. male hypopygium, ventral; e. eighth sternum of female.

FIG. 182. *Bibio abbreviatus* Loew. a. ninth sternum and harpagones of male; b. posterior tarsus and apex of tibia of male; c. ninth tergum of male.

FIG. 183. *B. albipennis* Say. a. posterior basitarsus and tibial spurs.

FIG. 184. *B. albipennis beameri* n. sub. sp. a. ninth sternum and harpagones of male; b. ninth tergum of male.

FIG. 185. *B. albipennis* var. *tenuipes* Coq. a. anterior tibia of male.

FIG. 186. *B. atripilosus* James. a. ninth sternum and harpagones of male; b. ninth tergum and cerci of male.

FIG. 187. *B. cavolinus* n.n. a. head of female, lateral; b. ninth sternum and harpagones of male, ventral; c. ninth tergum of male; d. posterior tibia and tarsus of male.

FIG. 188. *B. cari* Curran. a. posterior tarsus and tibial spur, lateral; b. ninth tergum of male.

PLATE XXXVIII

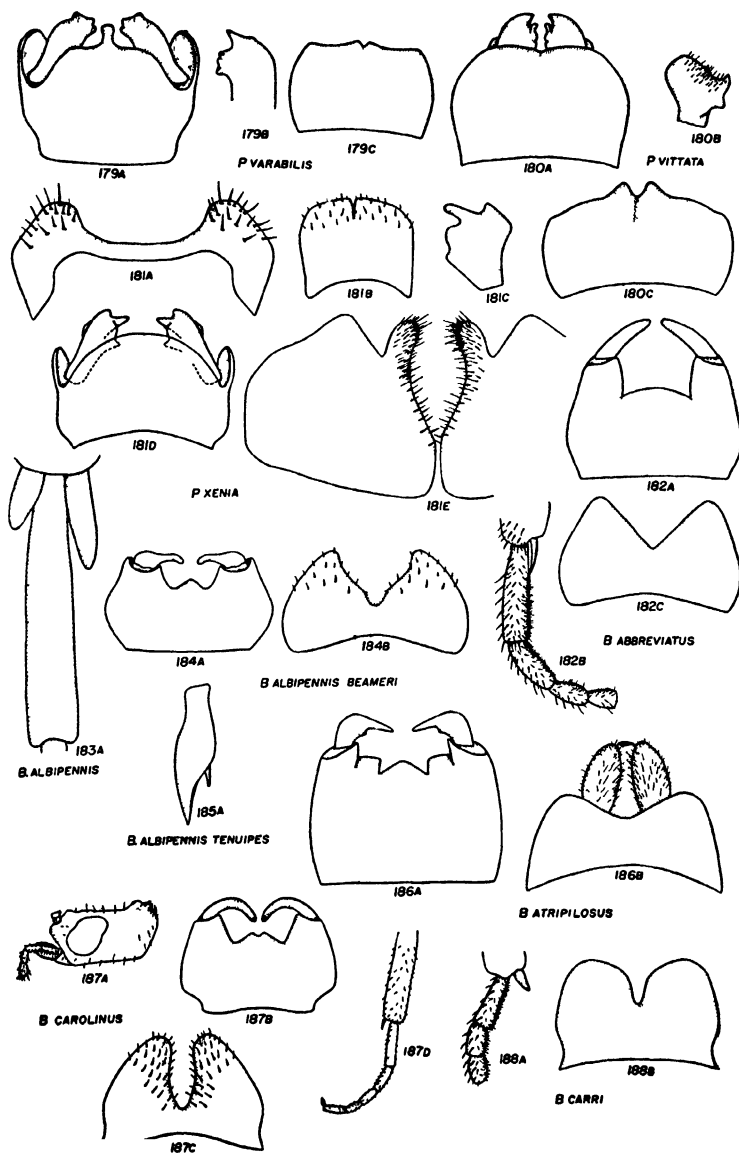


PLATE XXXIX

FIG. 189. *B. femoratus* Wiedemann. a. anterior tibia of male.

FIG. 190. *B. flukei* Hardy. a. posterior basitarsus and tibial spurs of male.

FIG. 191. *B. fraternus* Loew. a. posterior tarsus and tibial spurs of male, lateral; b. ninth tergum of male.

FIG. 192. *B. holti* McAtee. a. anterior tibia of male.

FIG. 193. *B. inaequalis* Loew. a. front tibia, lateral; b. front tibia, dorsal; c. ninth tergum of male; d. ninth sternum and harpagones.

FIG. 194. *B. kansensis* James. a. posterior metatarsus and apex of tibia of male, lateral.

FIG. 195. *B. knoultoni* var. *pallidus* Hardy. a. posterior tarsus and apex of tibia, lateral.

FIG. 196. *B. longipes* Loew. a. apex of front tibia and metatarsus of male; b. posterior metatarsus and tibial spurs of male.

FIG. 197. *B. melanopilosus* Hardy. a. wing; b. posterior metatarsus and tibial spurs of male; c. head of male.

FIG. 198. *B. monstri* James. a. ninth sternum and harpagones of male; b. harpago, dorsal; c. ninth tergum of male.

FIG. 199. *B. nervosus* Loew. a. ninth tergum of male; b. ninth sternum and harpagones; c. anterior tibia of male.

FIG. 200. *B. pingreensis* James. a. posterior metatarsus and tibial spurs of male.

FIG. 201. *B. rufithorax* Wiedemann. a. wing; b. head of female; c. ninth sternum and harpagones of male; d. front tibia; e. posterior tarsus of male; f. ninth tergum of male. (See also Fig. 201 on Plate XL.)

PLATE XXXIX

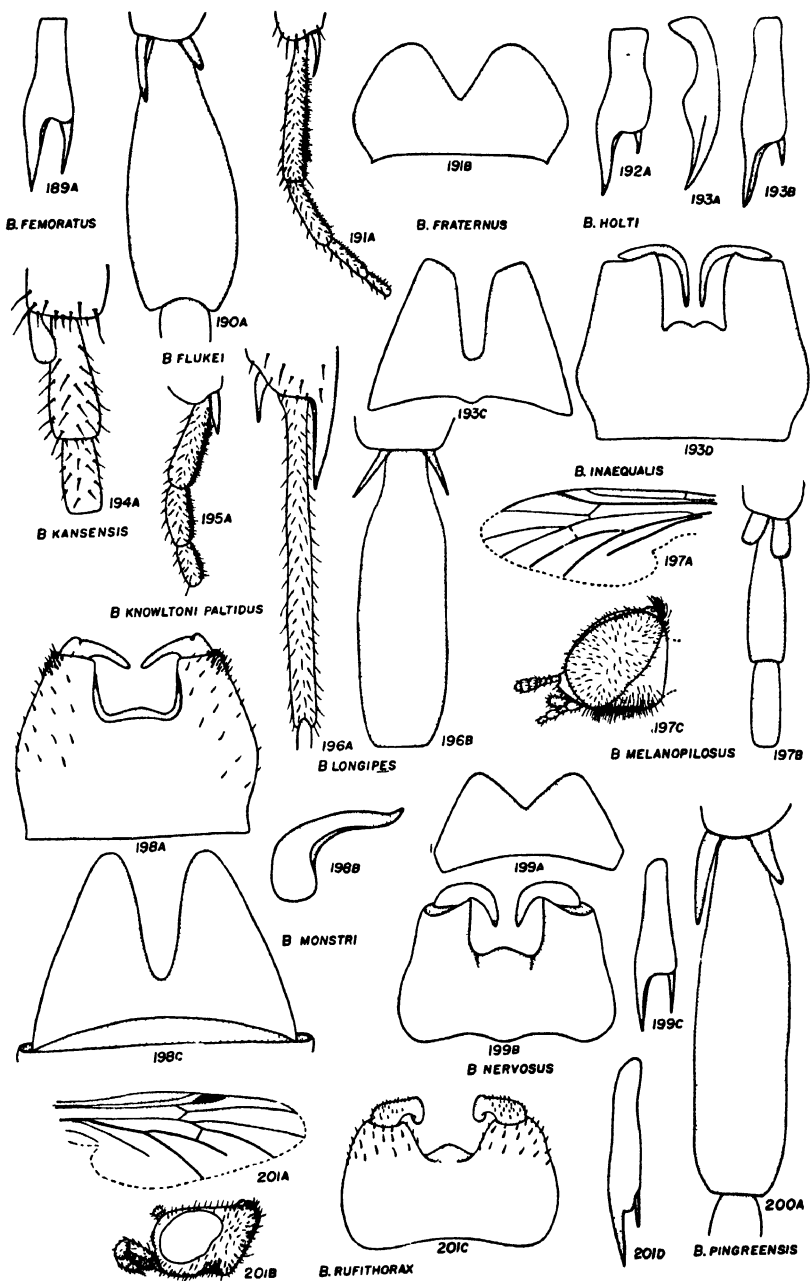


PLATE XL

FIG. 201. *B. rufithorax* Wiedemann. a. wing; b. head of female; c. ninth sternum and harpagones of male; d. front tibia; e. posterior tarsus of male; f. ninth tergum of male. (See also Fig. 201 on Plate XXIX.)

FIG. 202. *B. sericatus* Hardy. a. anterior metatarsus and tibial spurs of male; b. posterior metatarsus and tibial spurs.

FIG. 203. *B. townesi* n. sp. a. male genitalia, lateral.

FIG. 204. *B. xanthopus* Wiedemann. a. anterior tibia of male.

FIG. 205. *Bibiodes aestiva* Melander. a. male hypopygium, ventral; b. ninth tergum and cerci of male; c. wing.

FIG. 206. *B. femorata* Melander. a. male hypopygium, ventral; b. ninth tergum of male.

FIG. 207. *B. halteralis* Coquillett. a. male hypopygium, ventral; b. ninth tergum of male, showing left harpago and portion of sternum in dorsal view.

FIG. 208. *Philia breviceps* (Loew). a. male hypopygium, ventral; b. harpago, dorsal; c. harpago, lateral; d. ninth tergum of male.

FIG. 209. *P. caurina* (McAtee). a. ninth sternum and harpagones; b. harpago, lateral; c. ninth tergum of male.

FIG. 210. *P. emarginata* (McAtee). a. ninth tergum of male; b. ninth sternum and harpagones.

FIG. 211. *P. oklahomensis* Hardy. a. ninth sternum and harpagones, ventral; b. harpago, lateral; c. wing; d. ninth tergum of male.

PLATE XL

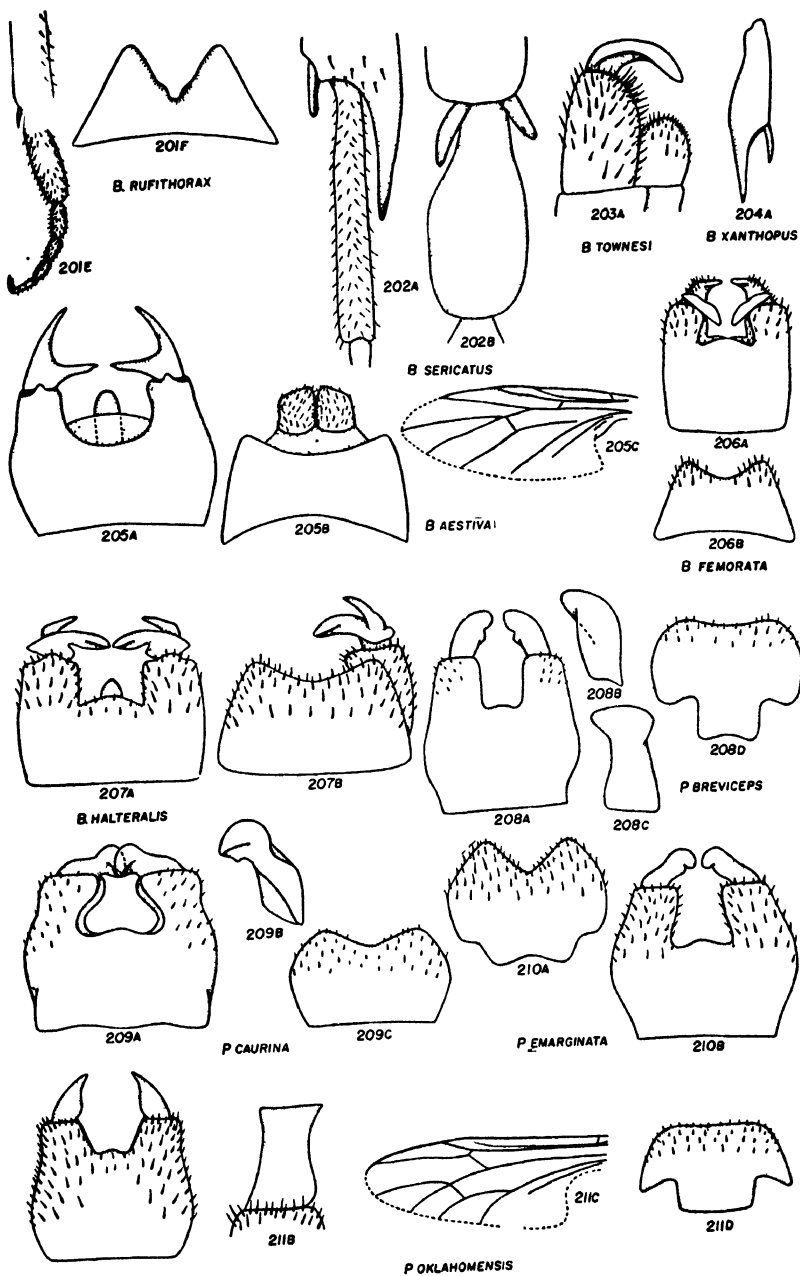


PLATE XLI

FIG. 212. *P. orbata* (Osten Sacken). a. ninth sternum and harpagones, ventral; b. male genitalia, dorsal; c. accessory structures above aedeagus.

FIG. 213. *proxima* (McAtee). a. ninth sternum and harpagones; b. ninth tergum of male; c. harpago, lateral.

FIG. 214. *P. scrotina* (Loew). a. ninth sternum and harpagones; b. ninth tergum of male.

FIG. 215. *P. spinipes* (Say). a. front tibia of male; b. ninth sternum and harpagones.

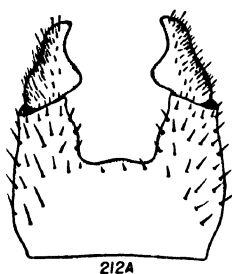
FIG. 216. *P. stigmatica* (Say). a. ninth sternum and harpagones; b. ninth tergum of male.

FIG. 217. *P. strigilata* (McAtee). a. ninth tergum of male; b. ninth sternum and harpagones.

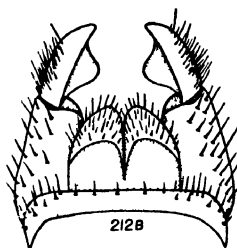
FIG. 218. *P. tibialis* (Loew). a. ninth sternum and harpagones; b. ninth tergum of male.

FIG. 219. *P. tingi* n. sp. a. anterior tibia of male.

PLATE XLI



212A

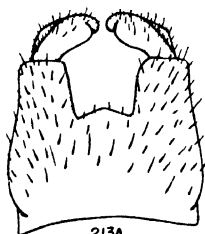


212B



212C

P ORBATA



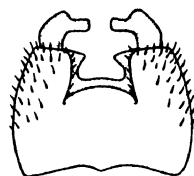
213A



213B



213C



214A

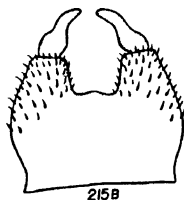


214B

P SEROTINA

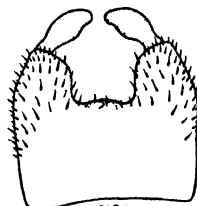


215A



215B

P SPINIPES



216A

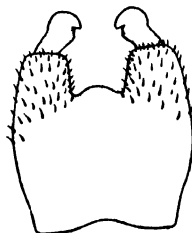
P STIGMATICA



216B

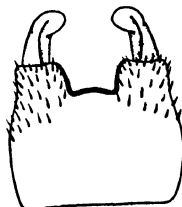


217A

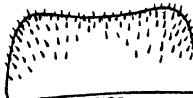


217B

P STRIGILATA



218A



218B

P TIBIALIS



219A

P TINGI

THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

VOL. XXX, pt. II.]

JUNE 15, 1945

[No. 16

The Occurrence of *Eucastor* and *Epigaulus* in the Lower Pliocene of Trego County, Kansas

By CLAUDE W. HIBBARD, University of Kansas, and LESTER F. PHILLIS, Canton, Kan.

ABSTRACT: A lower Pliocene deposit is reported from Trego county, Kansas. There have been collected from this deposit the remains of *Eucastor* cf. *tortus* Leidy, *Epigaulus minor* sp. nov. and teeth of a small horse (*Nannippus*).

INTRODUCTION

VERY little is known about the occurrence of Lower Pliocene rodents in northwestern Kansas. New locality records of these rodents aid in giving a better picture of their past geographical distribution and contribute to our knowledge of the associated vertebrates.

Lester F. Phillis collected a right ramus of *Eucastor* in Trego county, Kansas, December 21, 1941. Associated with the beaver jaw were the teeth of a horse and a fragmentary catfish spine. In August, 1943, John C. Frye and Claude W. Hibbard visited the locality in Trego county where Phillis collected the specimen of *Eucastor*. They collected a skull, lower jaws and other skeletal elements of an *Epigaulus*, a nearly complete catfish spine, and fragmentary horse teeth.

The tertiary deposit at this locality is a thin veneer on the underlying Cretaceous beds. It is a stream deposit channeled into the Cretaceous, and thins laterally into what appears to be the edge of the old flood plain. It was from the thin flood plain deposit that the *Epigaulus* was collected.

Section measured where secs. 15, 16, 21 and 22, T. 11 S., R. 22 W., corner
Trego county, Kansas.

5. Top soil.	
Pliocene.	Feet
4. Fine sand cemented with caliche, gray pink (<i>Epigaulus</i>)	3.6
3. Medium sand with some lenses and thin beds of clay (Catfish spine and horse teeth)	10.5
2. Massive silty sand	2.3

1. Clay, tan to gray, with some sand grains (2.9 feet from base is 0.7 foot of thin bedded, laminated, impure, volcanic ash, interlaminated with silt and clay)..... 5.0

Cretaceous.

We are grateful to Doctor Edwin H. Colbert of The American Museum of Natural History for permission to study specimens in the museum collection.

Following is a description of the specimens collected at this locality.

Eucastor cf. tortus Leidy

Figure 1

A right lower jaw, KUMVP No. 6885, was collected by Lester F. Phillis, December 21, 1941, from the northwest corner of sec. 22, T. 11 S., R. 22 W., Trego county, Kansas, which is referred to the above form. The specimen has been donated to the Kansas University Museum of Vertebrate Paleontology by Lester F. Phillis. It differs from the American Museum of Natural History specimen No. 10822, figured by Stirton (1935, p. 429, figs. 93, 94) in that it is slightly larger; M_1 is not as reduced and the teeth show a greater amount of wear. P_4 possesses a well-developed hypostridium. A shallow mesostridium is present, but it will soon disappear with wear; the metafoissettiid is absent. M_1 with greater transverse diameter than M_2 , both teeth possess a hypostridium which extends below the alveolar border. Internal striids absent. M_2 is missing, though the alveolus does not look reduced enough for the M_3 of *E. tortus*. It appears to have possessed an M_3 as large as the M_3 of *Eucastor planus* Stirton. The pit between M_3 and the coronoid process is not as well-developed as the pit in *E. planus*. Alveolar length of P_4 - M_3 is 17.0 mm. The anteroposterior diameter of P_4 is 6.4 mm.; the greatest transverse diameter is 4.6 mm. The anteroposterior diameter of M_1 is 3.6 mm.; its greatest transverse diameter is 4.6 mm. The anteroposterior diameter of M_2 is 3.5 mm.; its greatest transverse diameter is 4.2 mm. The anteroposterior diameter of the alveolus of M_3 is 3.4, its greatest transverse diameter is 3.4 mm. The depth of the jaw below M_3 is 11.0 mm. The length of the diastema is 15.5 mm. The width of the lower incisor is 4.3 mm.

Another occurrence of *Eucastor tortus* Leidy was reported by Hibbard (1942, p. 248) from Phillips county, Kansas. The specimen consisted of the fragmentary maxillaries with LP^4 - M^2 and RM^1 - M^3 , F: AM No. 24622 from the Childs Frick collection.

Epigaulus minor sp. nov.

Figure 2a-h

Holotype. No. 6886, Kansas University Museum of Vertebrate Paleontology; skull, associated lower jaws and other skeletal elements of an adult individual. Collected by John C. Frye and Claude W. Hibbard, August, 1943.

Horizon and type locality. Lower Pliocene, Locality No. 29, Trego county, Kansas.

Diagnosis. Smaller than *Epigaulus hatcheri* Gidley. Upper and lower premolars and molars with cement forming part of occlusal surface.

Description of Type. The specimen is that of an old adult. The base of the skull is shattered; neither of the lower jaws is complete. Other associated bones are parts of vertebrae, rib fragments, a few toe bones and claws, right scapula, right humerus, right ulna, right radius, left femur and a fibula.

The horns are not as high or as heavily developed as in *Epigaulus hatcheri*, though located posteriorly on the nasals with their posterior borders on a line with the anterior borders of the orbits. The nasals extend past the mid-line between the anterior border of the orbits and the postorbital processes. The postorbital processes are weakly developed. The sutures between the frontals and parietals are unidentifiable and it appears that these bones are fused. The skull is not as saddle-shaped as in *E. hatcheri* and the supraoccipital region is not as high.

There is a variation in the shape of the upper premolars. The right P^4 is more worn than the left and has six enamel lakes. The long internal lake is greatly reduced. There is a well-developed angle on the anterior lingual side of the tooth. This angle is not present on the left, which is oval in outline. The left P^4 possesses six enamel lakes. There are four enamel lakes present on M^2 and one on M^3 . There is a well-developed band of cement around P^4 , M^2 , and M^3 . The band of cement is as wide or wider than the enamel band of these teeth. The cement becomes thinner where P^4 and M^2 are in contact. The shortest distance across the palate between the upper premolars is 4.9 mm. The distance across the palate between the last upper molars is 7.45 mm. The transverse width of the upper incisor across its anterior face is 4.15 mm. There is an indication of a slight groove on the outer and medial surface of the incisor.

The left lower jaw is nearly complete though M_2 and M_3 are lacking. P_4 has eight enamel lakes. The transverse width of the lower

incisor across its anterior face is 4.0 mm. The incisor and angle are lacking on the right jaw. The right P_4 possesses seven enamel lakes. The difference in the number of lakes is due to the fact that the third lingual enamel lake from the posterior border in the left P_4 has worn down and divided into two small enamel lakes. Right M_2 is greatly worn and possesses only a small enamel lake on the labial side of the tooth. M_3 possesses a well-developed crescentic enamel lake. There is a well-developed band of cement around P_4 , M_2 , and M_3 except where the teeth contact each other. The band of cement is as wide as the enamel or wider and is a part of the occlusal surface of the teeth. The coronoid process is broken in both jaws but it extended well above the condyle. The incisor is still present at the level of the condyle. The mental foramen is small. The dental foramen is 2.5 mm., posterior to M_3 , and it is in line with the labial border of M_3 .

The specimen of *Epigaulus minor* has been carefully compared with Cope's type of the genus *Mylagaulus*. Mrs. Rachel Husband Nichols of The American Museum of Natural History has kindly furnished the following data concerning the type of *Mylagaulus sesquipedalis* Cope, from R. S. Hill's 1877 field book. "The field book is headed 'Tertiary Collections in the Loup Fork Formation in Northwestern Kansas on Sappa and Beaver Creeks.' The type, AM No. 8329, was collected by R. S. Hill in 1877 on Sappa creek, Decatur county, Kansas." We do not know whether the deposit in Decatur county from which *Mylagaulus sesquipedalis* Cope was collected is the same age as the Trego county deposit or whether it is older or younger. The type appears to be a LP^4 . It is from a young adult animal. It has not worn down to its maximum anteroposterior diameter, nor is the enamel pattern fully developed.

The occlusal surface of the type has an anteroposterior diameter of 7.9 mm. The greatest anteroposterior diameter of the tooth is 9.9 mm. The transverse diameter of the occlusal surface is 5.4 mm. The tooth has a length of 12.3 mm. The tooth when worn down would be approximately the size of that tooth in *Epigaulus minor*. Whether the pattern would be the same is unknown. At present there is no basis for assigning *Epigaulus minor* to *Mylagaulus sesquipedalis* Cope, except on the basis of size. The same condition exists for the type of *Mylagaulus monodon* Cope, taken from a deposit along Driftwood creek in Hitchcock county, Nebraska. It is only slightly smaller than *Epigaulus minor*; this comparison is based on P_4 . The following measurements were taken from the LP_4 of

Cope's type of *Mylagaulus monodon*, AM No. 8327. The enamel on the border of the tooth is broken, therefore the approximate antero-posterior diameter of the occlusal surface is 9.7 mm. The greatest anteroposterior diameter of the tooth is 10.5 mm. All three of these forms could belong to the same species. Sufficient material is not available to show both age and individual variation of the species under question.

Measurements of the type of *Epigaulus minor* nov. sp. and the type of *E. hatcheri* Gidley in Millimeters

	<i>Epigaulus minor</i> KUMVP No. 6886	<i>E hatcheri</i> * USNM No. 5486
Greatest width of skull across zygomatic arches,	60.5	64.0
Width of skull at occiput.....	65.0	75.0
Height of horn core above premaxillary.....	9.25	—
Anteroposterior diameter of horn core at base..	12.9	17.0
Conjoined width of horn cores.....	16.0	28.0
Width across postorbital process of frontals....	21.2	27.0
Depth of zygomatic arch beneath orbit.....	9.45	10.0
Length of diastema between I and P ⁴	17.0	23.0
Length of P ⁴ -M ³	14.9	20.0
Antoposterior diameter of P ⁴	9.1	13.0
Greatest transverse width of P ⁴	7.5	8.0
Anteroposterior diameter of M ²	3.2	—
Greatest transverse width of M ²	4.3	—
Anteroposterior diameter of M ³	1.9	—
Greatest transverse width of M ³	2.9	—
Over-all length of lower jaw	49.2	62.0
Lingual depth of lower jaw between molars....	13.0	19.0
Length of P ₄ -M ₃	15.5	20.0
Length of diastema between I and P ₄	10.0	—
Anteroposterior diameter of P ₄	11.5	15.0
Greatest transverse width P ₄	5.65	7.0
Anteroposterior diameter of M ₂	2.7	—
Greatest transverse width of M ₂	4.2	—
Anteroposterior diameter of M ₃	2.4	—
Greatest transverse width of M ₃	2.75	—
Over-all length of scapula	61.95	—
Over-all length of humerus	60.8	—
Over-all length of ulna	70.2	—
Over-all length of radius	42.2	—
Over-all length of femur	58.2	—
Over-all length of fibula	46.25	—

* After Gidley.

Nannippus sp.

Figure 3

Fragments of numerous horse teeth were found associated with the beaver jaw. Figure 3, KUMVP No. 6889, is the most complete upper molar taken from this deposit. It was collected by Lester F. Phillis. A fragmentary piece of a small camel jaw was found with the horse teeth.

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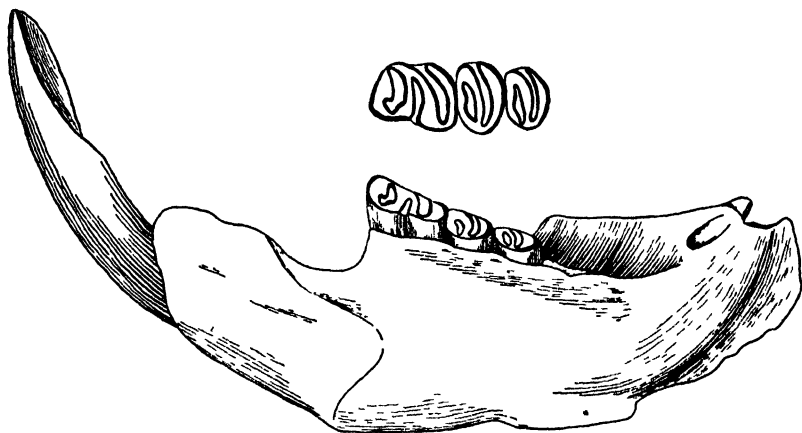


FIG. 1. *Eucastor* cf. *tortus* Leidy, right lower jaw, P₁-M₂, KUMVP No. 6885.
× 1. Drawing by Mrs Frances Horseman.

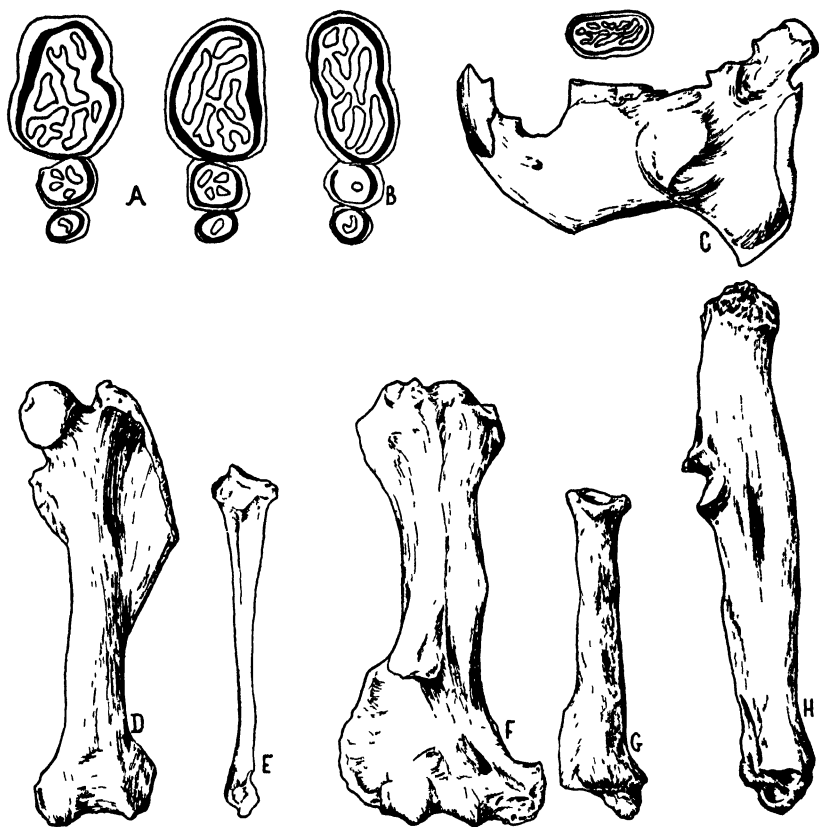


FIG. 2. Holotype of *Epigaulus minor* sp. nov., KUMVP No. 6886. (A) Occlusal view of RP^4 , M^2 , M^3 and LP^4 , M^2 , M^3 . $\times 2$. (B) Occlusal view of RP^4 , M^2 , M^3 . $\times 2$. (C) Left ramus with P^4 . $\times 1$. (D) Left femur. $\times 1$. (E) Fibula. $\times 1$. (F) Right humerus. $\times 1$. (G) Right radius. $\times 1$. (H) Right ulna. $\times 1$. Drawings by Miss Mary Frances Neidig.



FIG. 3. *Nannippus* sp., upper molar, KUMVP No. 6889. $\times 1$. Drawing by Miss Mary Frances Neidig.

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THE PUBLICATION OF THE RESULTS OF
RESEARCH BY MEMBERS OF THE
UNIVERSITY OF KANSAS

VOLUME XXXI, PART I
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LAWRENCE, MAY 1, 1946

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1946
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THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

Vo. XXXI, pt. I.]

MAY 1, 1946

[No. 1

List of Research Publications from the Science Departments from July 1, 1944, to June 30, 1945

Compiled by HOMER B. LATIMER

WE ARE listing the research publications of the science faculty in addition to the ten papers which are published in this number. We hope that this list will give a fairer idea of the research that is being done than the limited number of papers which can be published in this BULLETIN. A request for titles was sent to all science departments and we hope that all titles sent in are correctly published here. This list does not include any books, for this is an attempt to list only the research work which is being done here at the University of Kansas and which has been published in various national journals.

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A Summary of Mexican Lizards of the Genus *Ameiva*

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ABSTRACT: The eleven forms of *Ameiva* known in México are summarized with a key, diagnosis, statements of ranges, lists of localities, tabulations of variation, and discussion of intergradation and characteristics. A possible phylogeny of the races of *Ameiva undulata* is suggested.

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PREFACE

ANY observer of the trend of recent literature upon *Ameivas* would not fail to notice that interest in the Mexican forms of *Ameiva undulata* has been rising to a crescendo whose peak surely could soon be anticipated. The present summary certainly cannot claim the finality of such heights, but does add considerable new information and a number of interpretations to the growing mass of knowledge and theory regarding Mexican *Ameivas*.

We have attempted here to summarize briefly the previous contributions to the knowledge of Mexican *Ameiva undulata*. We have reëvaluated and recorded some of the variations of the subspecies on the basis of more specimens than any other authors have had available. Diagnoses of all the forms of *undulata* occurring in México, at least to the extent now known, are included. It has been our aim to establish more precisely than has been done before the ranges and areas of intergradation of the several forms involved. A possible course of phylogeny of all forms of *undulata* is discussed, and we present a key which may facilitate identification of Mexican specimens.

Since there is little variation in most features of scutellation of the species we have not described them in detail for all forms. For the benefit of those interested we have included a more or less complete description of one form, *A. u. dextra*. Other forms differ little from this description save in the characters receiving special note.

For the sake of completeness we have added the only other *Ameiva* of México, *A. festiva edwardsii*.

HISTORICAL SUMMARY

When *Ameiva undulata* was first described over 100 years ago, Wiegmann (1834) recognized the existence of a related form, which he called variety A. Bocourt (1874: 254-259) also recognized a variety A (by his statement the same as Wiegmann's variety A) and a variety B. Both varieties appear to belong to the race now known as *Ameiva undulata hartwegi*.

For some time no further attempt was made to distinguish the Mexican races of Mexican *Ameiva undulata*. Neither Boulenger (Catalog of Lizards) nor Günther (Biologia Centrali-Americana) recognized any variants in 1885. And in 1915 Barbour and Noble, in their monograph of *Ameiva*, still placed all Mexican specimens in *Ameiva undulata undulata*. They recognized two Central Amer-

ican races, one of which (*u. parva*) has since been recorded in México, while the other *u. quadrilineata*, is now known by the earlier name of *u. pulchra*. In 1934 Stuart tentatively (and incorrectly) allocated the name *A. u. parva* with specimens from the Petén area of Guatemala, although in 1935 he reverted to "*Ameiva undulata*" for them. Not until 1937 was there a further advance toward the understanding of Mexican races. In that year (1) Hartweg and Oliver cited the need for revision, and stated that specimens from the Yucatán and Petén areas are different from Tehuantepec specimens; and (2) Smith recognized an "*Ameiva undulata parva*" from Yucatán and an "*Ameiva undulata undulata*" from Campeche and Veracruz. Smith's allocation of both names was incorrect; in reality neither of his races possessed a name at that time.

In 1940 Smith corrected his previous erroneous allocation of the name *parva*, proposing *A. u. hartwegi* for the race; restricted the type locality of *undulata* to Tehuantepec, and named as *A. u. stuarti* the Campeche form which he had previously called *A. u. undulata*. Thus at that time three forms of *Ameiva undulata* were known in México. Dunn, later in the same year, hesitated to segregate races of *Ameiva undulata* either in México or in Central America, holding his decisions in abeyance for the appearance of Stuart's summary. In the following year, 1941, Schmidt and Stuart commented further upon the races of *Ameiva undulata*, accepting the races proposed previously, correctly allocating the name *u. parva* for the first time with the Pacific coast race ranging from the Isthmus of Tehuantepec to Guatemala, and pointing out the proper use of the name *u. pulchra* for the race Barbour and Noble had called *u. quadrilineata*.

Stuart's review of the entire *undulata* group of *Ameiva* appeared in 1942. In it he recognized four Mexican subspecies of *undulata*. He regarded the Pacific coast material from west of Tehuantepec as probably distinct from typical *u. undulata*, but refrained from defining it. His discussion of diagnostic characters, variation and phylogeny of the group is the only attempt that has been made along such lines.

MATERIALS

The present study is based chiefly upon the Mexican specimens of *Ameiva undulata* in the Walter Rathbone Bacon collection secured by Smith from 1938 to 1940; in the E. H. Taylor-H. M. Smith collection; in the collection of the Museum of Zoölogy of the University of Michigan (part only); and in the U. S. National Museum collection (part only). These collections are indicated by the ab-

abbreviations HMS (uncatalogued specimens only; all Bacon specimens are on deposit at the U. S. National Museum and those entered in the permanent collection of that institution bear regular USNM numbers), EHT-HMS, UMMZ and USNM, respectively. The entire series includes some 875 specimens, and according to our interpretations represents 10 forms.

The material examined of *A. festiva edwardsii* includes some 50 specimens in the Bacon collection. No other Mexican specimens have been recorded in other U. S. collections.

CHARACTERS

As Stuart (1942: 146) has emphasized, in diagnosing the forms of the *undulata* group "a number of characters prove useful but few are infallible and, for the most part, they can be applied only to populations rather than to individuals."

PRIMARY CHARACTERS

There are a few characters which almost all students who have dealt critically with this group have realized are of primary significance. These are: (1) size and arrangement of the median gular scales, (2) arrangement of the preanals, and (3) separation of the third supraocular from the median head scales and, by two rows of granules, from the superciliary scales.

Gulars. The median gulars may be small and irregular, merging gradually with adjacent scales (Fig. 1C), abruptly enlarged and irregular (Fig. 1D), or abruptly enlarged and arranged in a single longitudinal row (Fig. 1B). Between these extremes variations do occur, although the usual condition in any one race as a whole places that race rather definitely in one of these groups. As one example of intermediate type, we may cite the occurrence of occasional specimens of *u. gaigeae* which have the central gulars aligned in a single row much as in Fig. 1B, although they are usually irregular as shown in Fig. 1C. In *u. podarga* two or three scales may be aligned at times, instead of all being irregular.

Prianals. The preanals are paired in most races (as in Fig. 2A), but in one (*u. undulata*) there is a single median row and on each side a smaller row (Fig. 2B). A specimen in which the former condition exists is said to have two rows of preanals, while those like *u. undulata* are said to have one row. In *u. sinistra* occasionally, and in *u. dextra* usually, the posterior preanal is paired as in Fig. 2C. In these latter two races the preanals are otherwise arranged in a single row.

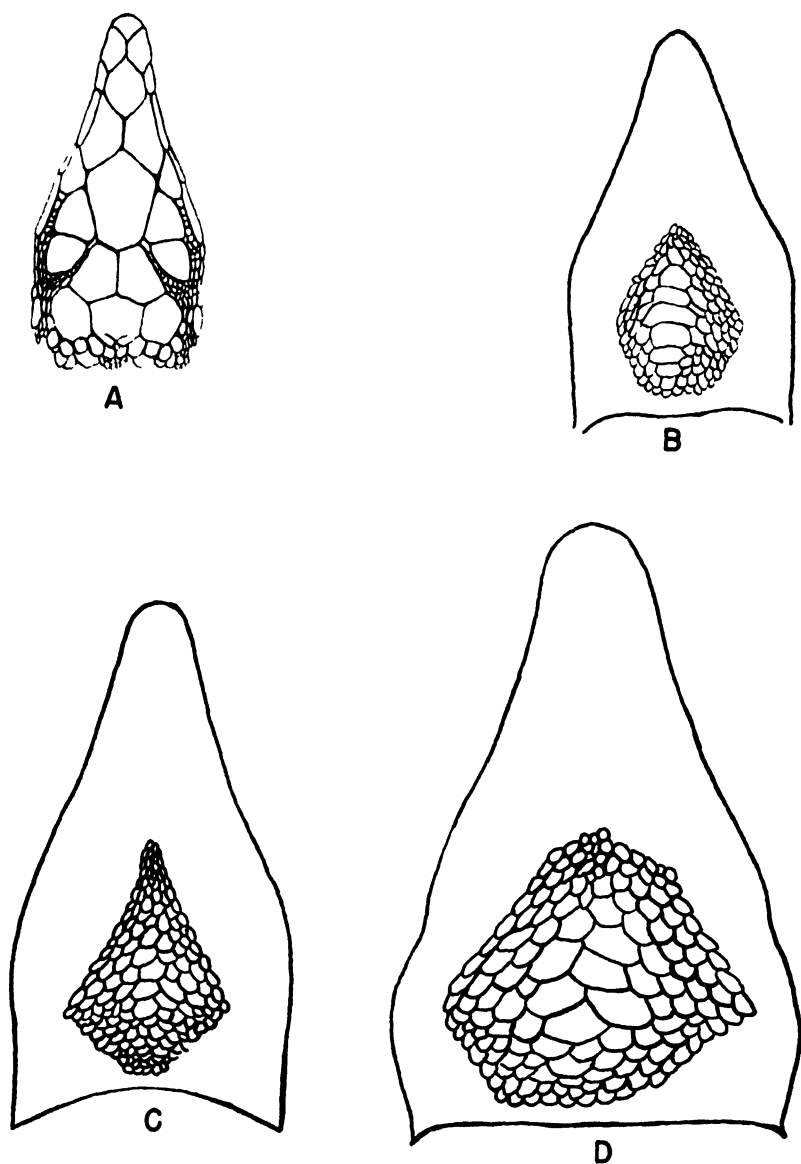


FIG. 1. A. Dorsal view of head scales of *A. u. parva*, HMS No. 14256, La Esperanza, Chiapas.
B. Gulars of *A. u. stuarti*, EHT-HMS No. 11952, San Ricardo, Chiapas.
C. Gulars of *A. u. gaigeae*, EHT-HMS No. 11927, Progreso, Yucatán.
D. Gulars of *A. u. podarga*, HMS No. 1597, Huichihuayán, San Luis Potosí.

Supraocular scales. In only one race, *u. parva*, the posterior supraocular is usually separated completely from the frontal and frontoparietal by a row of small scales. The same supraocular is likewise separated from the superciliaries by, usually, two rows of granules instead of a single row as in other races. The row of small scales between the supraocular and median head scales is short, allowing contact of the frontal or frontoparietal (or both) with the supraocular. These features in *u. parva* are illustrated in Fig. 1A.

SECONDARY CHARACTERS

Of secondary or racial significance are (1) pattern characters of varying types, including particularly the dorsal spotting and the nature of the dorsolateral and lateral dark and light spots, stripes and bars; (2) the number of lamellae under the fourth toe; (3) the number of femoral pores; (4) the exact character of the ulnar (number of enlarged scales, regularity); (5) the size of the lateral gulars; and (6) the exact character of the preanals (whether one or more is split, and number of rows).

We have been unable to find other characters that are variable intersubspecifically and are not at the same time nearly equally variable intrasubspecifically. Some of these, in fact—the number of femoral pores and lamellae—Stuart (1942: 47) regards as of no diagnostic value whatever. As illustrated by the several tables included herewith, we believe them to be of considerable value in some cases. For example, in *A. u. stuarti* only one of the 72 lamellar counts is over 28, while all those (97) of the adjacent race *A. u. hartwegi* are 29 or over.

Our methods of treating data on the six secondary characters listed above are explained consecutively in the following.

Pattern. A number of forms typically possess numerous, irregular, dark spots on the back, arranged more or less in two rows. Others lack spots completely or else have very small ones. There is some variation intrasubspecifically, but in most forms it is not great. This character is particularly useful in distinguishing *u. dextra* from the two adjacent forms, *u. sinistra* and *u. undulata*.

Of greatest significance so far as pattern is concerned, however, is the nature of the dorsolateral and lateral pattern. Light and dark stripes, transverse bars and spots are the chief components. Some forms appear rather distinctly striped, others barred, and combinations of both types of pattern with neither particularly prominent is common. As Stuart (1942: 147) has pointed out, ontoge-

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netic changes and sexual dimorphism in pattern occur in most forms. Juveniles of both sexes and all females tend to have a more linear pattern than adult and subadult males, which tend to stress the barred elements of the pattern. Adult males are more brightly marked than other specimens.

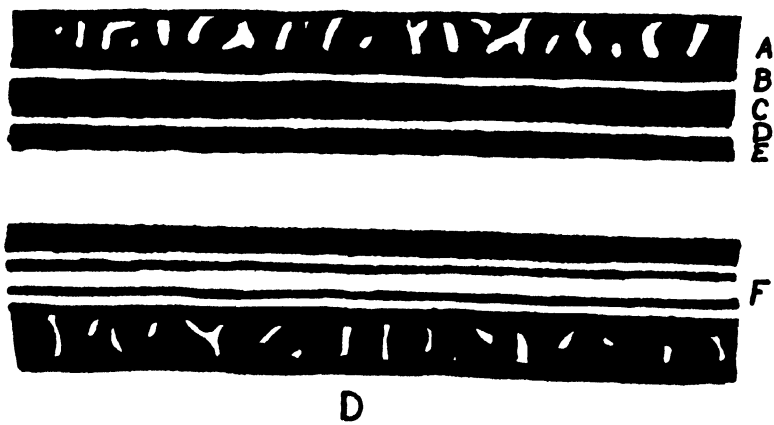
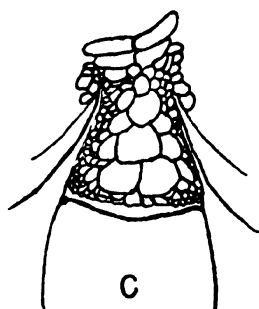
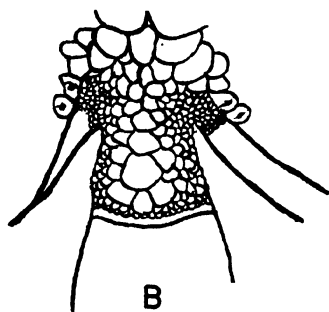
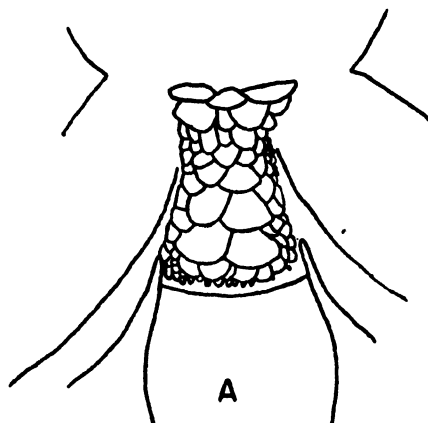
The most primitive patterns apparently are those in which stripes predominate, as in *u. stuarti*. Fig. 2D is a diagram of the stripes that may occur in *undulata*. Dorsolateral light stripes (D) are typical and are distinct in the young if not in the adult, or the position of the stripe is clearly evident where the adjacent dark upper lateral stripe (C) meets the broad, light middorsal area. In *u. stuarti* only, a distinct dorsolateral dark stripe (E) borders the dorsolateral light stripe medially; in all other forms the medial border of the latter is formed by the light middorsal area, which obviously meets the upper lateral dark stripe in case the dorsolateral light lines are poorly developed or absent. In *u. amphigramma* a light line develops in the middle of the upper lateral dark line; this we call the upper lateral light line (F). In several forms (particularly *u. podarga*, *u. dextra*, *u. sinistra*, and *u. thomasi*) the upper lateral light line is represented by large spots, which either remain isolated in the dark stripe (as in *u. podarga et al.*) or fuse with the dorsolateral light stripe (as in *u. thomasi*).

A lateral light stripe (B) is of general occurrence, but is usually broken into short lines or into spots. Frequently in adult males it is not evident, being either fused with transverse lines or completely absent.

A broad lateral dark zone (A) borders the lateral light line ventrally. It is frequently marked with irregular light spots which tend to be elongate or oval and oriented transversely. Enlargement of these irregular light spots results in a fusion with the lateral light line (or parts thereof) and sometimes with the upper lateral light spots. Specimens in which such a fusion has occurred have irregular transverse light bars on the sides, producing a "tigroid" pattern. The width of the dark interspaces varies considerably, but is, within rather generous extremes, fairly constant for any one form. The narrower the dark bars, the more striking the tigroid effect becomes.

Lamellae. We have counted only the lamellae under the 4th toe, although differences in the lamellar counts of other digits are probably equally significant.

The lamellae on the three basal phalanges of the 4th toe are divided, and differ in number on the two sides. Those on the anterior surface (toward the third toe) are larger and apparently more con-



- FIG. 2. A. Preanals of *A. u. podarga*, HMS No. 1597, Huichihuayán, San Luis Potosí.
 B. Preanals of *A. u. undulata*, HMS No. 18543, Tehuantepec, Oaxaca.
 C. Preanals of *A. u. dextra*, EHT-HMS No. 11682, Acapulco, Guerrero.
 D. Diagrammatic scheme of dorsal and lateral pattern of *A. undulata*.
 A. Lateral dark line.
 B. Lateral light line.
 C. Upper lateral dark line.
 D. Dorsolateral light line.
 E. Dorsolateral dark line.
 F. Upper lateral light line.

stant than those in the posterior row. For that reason our counts were made along the preaxial border of the digit.

Fortunately it has been possible to mark an exact basal point from which the counts begin. A relatively large, single tubercle is present at the base of the 1st phalanx, immediately preceding the paired lamellae. Our counts begin with that tubercle as No. 1. Occasionally a single small tubercle precedes it, instead of paired scales; in such cases the count still begins with the larger, proximal tubercle.

The total range of variation in lamellar counts of Mexican *undulata* is from 22 to 36, the minimum occurring in *u. stuarti*, the maximum in *u. hartwegi* and *u. gaigeae*. The maximum range in any one form is 11 (*u. gaigeae*, 26-36), the minimum 7 in forms represented by a reasonable number of counts (*u. sinistra*),* the average 9, excluding doubtfully complete series (*u. stuarti* 9, *u. amphigramma* 10, *u. parva* 8, *u. hartwegi* 8).

TABLE 1. Racial Variation in Lamellae and Pores

RACE.	Lamellae.			Pores.		
	Counts.	Range.	Average.	Counts.	Range.	Average.
<i>stuarti</i>	72	22-30	25.5	73	13-18	15.5
<i>podarga</i>	30	28-31	29.4	31	13-18	15.8
<i>amphigramma</i>	187	24-33	27.7	180	14-23	17.0
<i>thomasi</i>	17	25-30	28.4	18	14-20	17.2
<i>parva</i>	97	26-33	29.1	98	13-21	16.4
<i>dextra</i>	20	27-31	28.9	24	15-21	18.2
<i>sinistra</i>	111	26-32	29.6	121	15-22	18.1
<i>undulata</i>	94†	25-30	27.7	162†	13-20	16.8
<i>hartwegi</i>	97	29-36	31.8	100	16-23	20.5
<i>gaigeae</i>	132	26-36	30.4	138	15-22	18.5

‡ All from Hartweg and Oliver, 1937: 7.

† Of these 94 counts are from Hartweg and Oliver, 1937: 7.

* Unreliable are *u. podarga* (31 counts, range 4), *u. thomasi* (17 counts, range 6), and *u. dextra* (20 counts, range 5).

The lowest average number of lamellae is 25.5 (*u. stuarti*), the highest 31.8 (*u. hartwegi*). For all races the mean average is 29.

Femoral pores. The number of pores has been found useful in the diagnosis of most of the races of *undulata*, separating almost all from at least one close relative. The most useful comparisons have been possible between *u. stuarti*, *u. hartwegi* and *u. gaigeae*. In other forms average differences may occur, but they do not always reach a minimum of seventy percent reliability desirable for a useful character. In some cases we have found it desirable to compare the total pore counts rather than those on one thigh only.

The total range of variation in Mexican *undulata* pore counts is 11, the actual counts varying between 13 and 23. The minimum number occurs in *u. stuarti*, *u. parva* and *u. undulata*, the maximum in *u. amphigramma* and *u. hartwegi*. The maximum range of variation in any one form is 10 (*u. amphigramma*, 14 to 23), the minimum 6 (*u. stuarti* and *u. podarga*, 13 to 18), the average 8 (*u. thomasi*, *u. dextra*, 7; *u. sinistra*, *u. undulata*, *u. hartwegi*, *u. gaigeae*, 8; *u. parva*, 9).

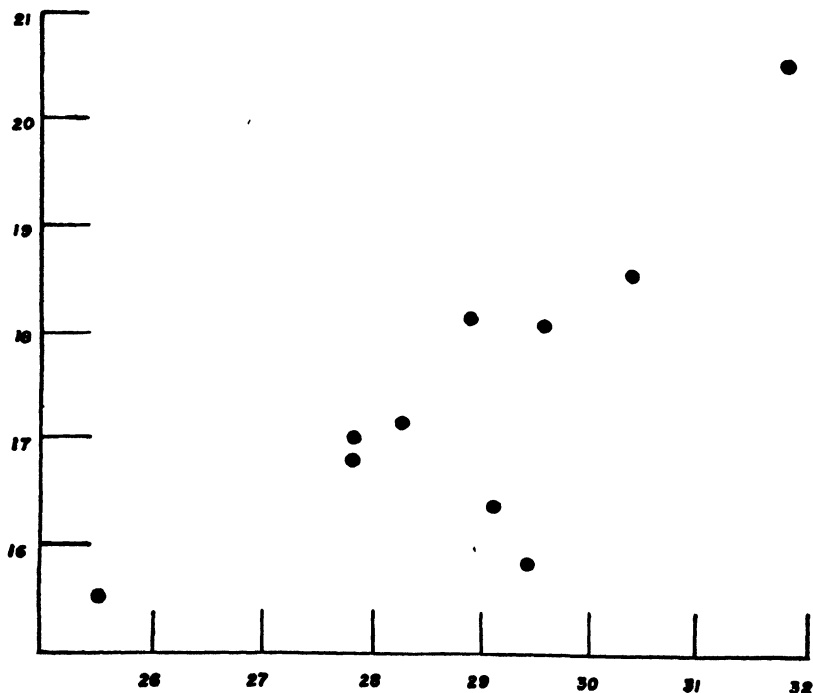


FIG. 3. Correlation in average femoral pore and lamellar counts of the races of *Ameiva undulata*. Based on Table 1. Abbreviations for subspecific names: st, *stuarti*; p, *podarga*; a, *amphigramma*; t, *thomasi*; pa, *parva*; d, *dextra*; s, *sinistra*; u, *undulata*; h, *hartwegi*; g, *gaigeae*.

The lowest average number of pores is 15.5 (*u. stuarti*), the highest 20.5 (*u. hartwegi*). For all races the mean average is 17.4.

There is a direct correlation in variation in number of pores and of lamellae at least racially; we have not attempted to determine whether there is a similar correlation individually. In general, the higher the average number of pores, the higher the average number of lamellae (Fig. 3). *A. u. parva* deviates most conspicuously from this correlation, although it is not far from the expected position. *A. u. podarga* is not represented by sufficient counts to be significant in its apparent divergence. All others are arranged closely about the line of correlation.

It is noteworthy that in average count, in maximum count and in minimum count, *u. stuarti* is the lowest and *u. hartwegi* the highest, in respect both to lamellae and pores. In other respects as well the races are the most widely differentiated of any in the species that occupy adjacent ranges.

Median gulars. We have already mentioned that the abruptness of enlargement of the median gulars is a character readily segregating *u. gaigeae* and *u. hartwegi* (not abruptly enlarged) from all other forms. The character of these scales is of still further use, however, in defining some forms. We recorded variation in two features: number of rows of central gulars, and number of regular and irregular scales.

The number of rows of gulars recorded included only those containing notably enlarged scales. In spite of the arbitrary nature of the count, marked differences definitely do occur. In *u. stuarti*, for example, a relatively large number of gulars (6 to 8) occurs; they are arranged very neatly in a median row which typically is bordered by much smaller gulars not perceptibly increasing in size medially. In most other forms there are fewer median gulars, but they are larger than in *u. stuarti* and somewhat more irregularly arranged. This difference has been used diagnostically in comparing *u. podarga*, *u. amphigramma* and *u. stuarti* with each other.

The regularity of arrangement of the gulars was measured by counting the number of more or less symmetrical scales (exceeding one) aligned in the midventral line. A minimum of two was recorded since even completely irregular scales might accidentally include one oriented medially.

In considering irregularity (as opposed to regularity) of the gulars some standard is necessary, since the anterior and posterior median gulars tend to be irregular and blend into the adjacent smaller gulars. We therefore selected a maximum of five gulars to be con-

sidered when counting the number of irregular scales. The five observed were the largest and most typical scales of the group. This number was selected of necessity because it was the smallest number of rows of enlarged gulars found in any of the forms compared; a larger number would have necessitated the inclusion, in some cases, of small gulars preceding or succeeding the enlarged series or group.

Lateral gulars. We have observed a marked enlargement of the lateral gulars only in *u. thomasi*. In other races the gulars are very nearly uniform throughout, except of course for the median area, but may be slightly enlarged laterally in the region of the jowls. The greater enlargement in *u. thomasi*, while clearly evident by direct comparison, is not prominent enough to be particularly useful in diagnosis.

Prenals. As stated previously, the preanals are arranged in two strikingly different ways: in a single or a pair of median rows. We have observed no variation of significance in the condition of paired median preanals, but the condition of an azygous row does show some variation of subspecific significance.

There are three races which belong in the group with azygous preanals: *u. undulata*, *u. dextra*, and *u. sinistra*. In *u. dextra*, however, the last large preanal is usually paired (see Fig. 2C), a condition which may well mean an incomplete transformation from the primitive paired condition. In most *u. sinistra* all are single, and in a very few *u. undulata* are any large scales paired. In other words the latter race approaches the perfect azygous arrangement, and therefore the peak of specialization along this line, more closely than any other. *A. u. sinistra* is intermediate, and *u. dextra* the least specialized.

In taking data on this character we found that there was some difficulty in determining what was to be considered the last preanal. Obviously the very small granules lining the cloaca are not to be counted, but these sometimes merge so gradually with the enlarged preanals that it is not certain just where the line of distinction should be drawn. For that reason it is well nigh impossible to compare homologous scales through large series of specimens of all the three forms involved. Moreover, in *u. undulata* the intermediate preanal-cloacal scales are frequently paired.

A moderately satisfactory solution to this dilemma was found by observing the number of rows of preanals. This was determined by following medially the row of scales in line with the femoral pores,

and from their point of union counting posteriorly the number of rows of enlarged scales. The anterior point for the counts was thus relatively constant in all cases. Posteriorly, again, some doubt was entertained on the terminus of the enlarged scales. Some variation is to be expected and did occur, so that our counts of the number of preanal rows are not to be regarded absolute. It is true, however, that *u. undulata* tends to have more rows of preanals than either *u. dextra* or *u. sinistra*. Observing only the fifth preanal, if one would count five rows or more, we found that the variation introduced by the numerous terminal rows was eliminated in most cases. This procedure was particularly helpful in dealing with *u. undulata*, yielding a high percentage (89%) of single posterior preanals. We would have had a nearly equal dispersal by taking the very last enlarged scales. In *u. dextra* and *u. sinistra* the rows of preanals average fewer than in *u. undulata*, and frequently the last enlarged preanal would be in the fourth row.

Accordingly, we arbitrarily decided that the paired or single condition would be recorded for the preanals of what definitely appeared as the last row of enlarged scales if the number of rows was found to be five or less; if over five, the character of the scales of the fifth row only was recorded.

SUBSPECIFIC SECTIONS

There are four morphological sections in *undulata*, distinguished on the basis of the primary characters previously outlined. Excluding *u. pulchra*, each section occupies a distinct and continuous range, and forms a natural unit. The exceptional form, *u. pulchra*, is most closely related to *u. hartwegi* and *u. gaigeae*, but is morphologically closest to the group containing *u. stuarti*, *u. podarga*, *u. amphigramma* and *u. thomasi*. The natural, subspecific groups or their ancestral stocks have been indicated in Fig. 4 by the Roman numerals I through IV. The forms of these groups may be listed as follows:

I. *A. u. pulchra*, *u. hartwegi*, *u. gaigeae* (two rows of preanals; small gulars*).

II. *A. u. parva* (two rows of preanals; large gulars; third supraocular separated).

III. *A. u. stuarti*, *u. podarga*, *u. amphigramma*, *u. thomasi* (two rows of preanals; large gulars; third supraocular not separated).

IV. *A. u. dextra*, *u. sinistra*, *u. undulata* (one row of preanals).

* Except *u. pulchra*, with enlarged gulars and other characters as in group III.

Allocation of *u. pulchra* with the subspecific group I, while on morphological grounds it belongs with group III, is prompted by geographic considerations discussed in the following paragraphs.

The distinctness of these four groups in México is rather striking. *A. u. undulata* is the most highly specialized of its group and thus sharply distinguished from *u. parva* and *u. amphigramma*, members of two adjacent sections. *A. u. stuarti* is so widely different from *u. hartwegi* and *u. gaigeae*, the members of an adjacent section, that it might well be considered a member of a different species. We have refrained from considering *u. gaigeae* and *u. hartwegi* collectively as a distinct species chiefly because of the existence of a slight approach of specimens of *u. stuarti* toward *u. hartwegi*. Actual intergrades still are not known, and for that reason the possible specific distinctness of *hartwegi* should be kept in mind. In such an arrangement, however, the problem of relationship to *u. pulchra* becomes acute, for it fits morphologically with some of the other races, although it presumably intergrades with *u. hartwegi*.

Incontrovertible intergrades are known only between sections II and IV, via *u. parva* and *u. undulata*, respectively. None is known between III and either II or IV, or between III and I, although they may occur.

PHYLOGENY

The phylogeny of Mexican races of *Ameiva undulata* is not entirely clear. Forms which differ so slightly as these furnish few clues to their early peregrinations and relationships. Nevertheless certain rather probable steps in the subspeciation of the group seem fairly evident. These steps may be segregated into four groups: those of (1) Lower and Middle Miocene, of (2) Upper Miocene and Lower Pliocene, of (3) Upper Pliocene and Lower Pleistocene, and of (4) Pleistocene and Recent times.

LOWER AND MIDDLE MIOCENE

It is conceivable that in the Lower and Middle Miocene,† when the Isthmus of Tehuantepec was above water, the *undulata* stock was distributed rather widely from southern and probably central (coastal) México through all available territories in Central America (Fig. 4A). Whether this stock was originally dispersed from the north or south is not particularly clear, but because of the indisputable South American center of dispersal of the family we may suppose that the *undulata* stock migrated northward.

† Paleogeography based on Schuchert (1935).

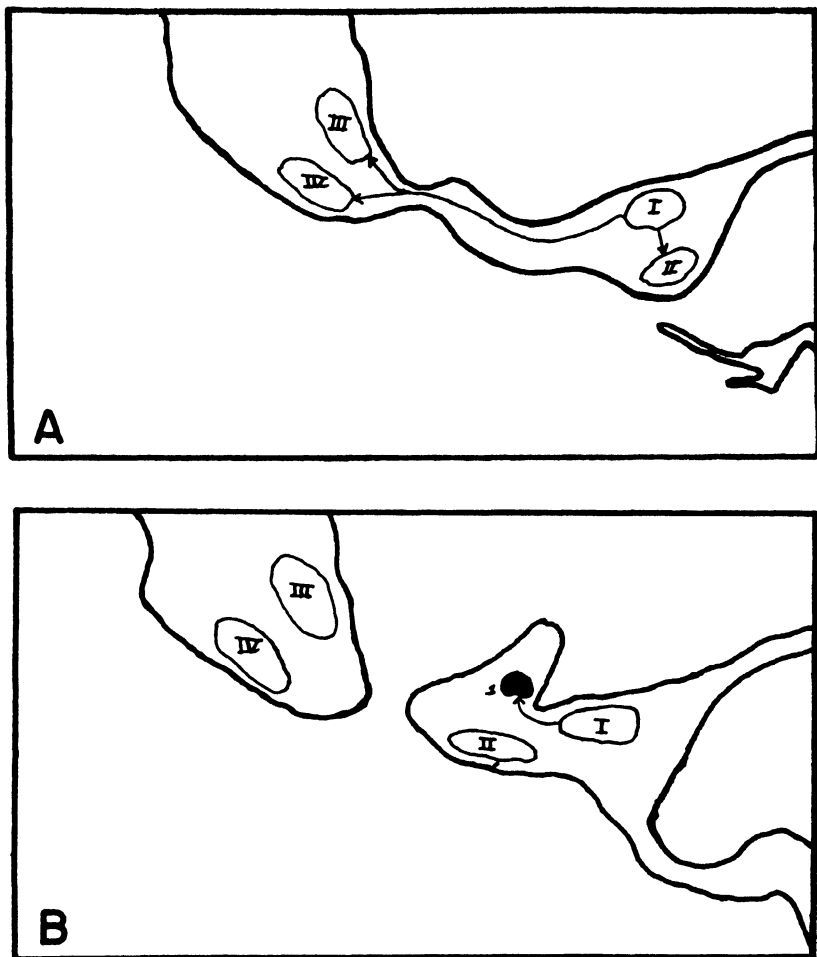


FIG. 4. Paleophylogenetic maps of *A. undulata*.

A. Lower and Middle Miocene.

B. Upper Miocene and Lower Pliocene.

I. *pulchra-hartwegi-gaigae* parent stock.

II. *parva* parent stock.

III. *podarga-amphigramma-thomasi-stuarti* parent stock.

IV. *undulata-dextra-sinistra* parent stock.

1. *hartwegi-gaigae* parent stock.

UPPER MIOCENE AND LOWER PLIOCENE

Since in this period these lizards were dispersed over a considerable area, some differentiation may have begun while the Tehuantepec portal (in reference to the oceans) was still closed. Whether it began then or after the opening of the portal in the Upper

Miocene and Lower Pliocene is relatively immaterial; it is clear enough that it proceeded apace with the isolation of México from Central America. Three physiographic features accomplished isolation of four groups of *undulata*. The ocean portal isolated northern and southern groups, and each of these was split by mountain ranges which reached very near if not quite to the ocean on both sides of the portal. The four groups are indicated by Roman numerals in Fig. 4B. They, in turn, became secondary centers of dispersal.

It is important to observe that these four groups, each (except II) represented today by three or more subspecies, are extremely clearly differentiated from each other at the present time, almost to the extent of comprising different species in some cases. No differences between the subspecies of any one group (except perhaps in I) are as great or greater than those between the groups themselves. That a lengthy isolation may have been responsible for such differentiation seems reasonable.

Obviously migration continued after isolation of the four groups. One of the most significant migrations occurred in group I, which occupied territory adjacent to a new, extensive area of land thrust above the sea as the Tehuantepec portal was opened. This new area occupies the approximate position of the present-day Yucatán Peninsula. Probably the animals migrating into this new territory became well differentiated morphologically from their parent stock; that differentiation under such conditions does occur is well illustrated by the extremely extensive subspeciation and speciation of animals which have repopulated the modern Yucatán Peninsula. The stock which migrated into and differentiated on the new Paleo-Yucatán Peninsula we may suppose is that which later gave rise to modern *u. hartwegi* and *u. gaigeae*. This stock is indicated on Fig. 4B by the Arabic numeral 1. Very likely it was similar to modern *u. hartwegi*. The theory of differentiation of the pre-*hartwegi-gaigeae* stock on a Paleo-Yucatán Peninsula accounts satisfactorily for the very extensive differentiation within Group I—a differentiation far greater than has occurred within any other group.

On the northern side of the portal, migration proceeded probably with some differentiation into races. This topic will be discussed later.

UPPER PLIOCENE AND LOWER PLEISTOCENE

In this period the Tehuantepec portal was closed and migration across the Isthmus again became possible. Three important changes took place. It would appear (1) that the migration was effected

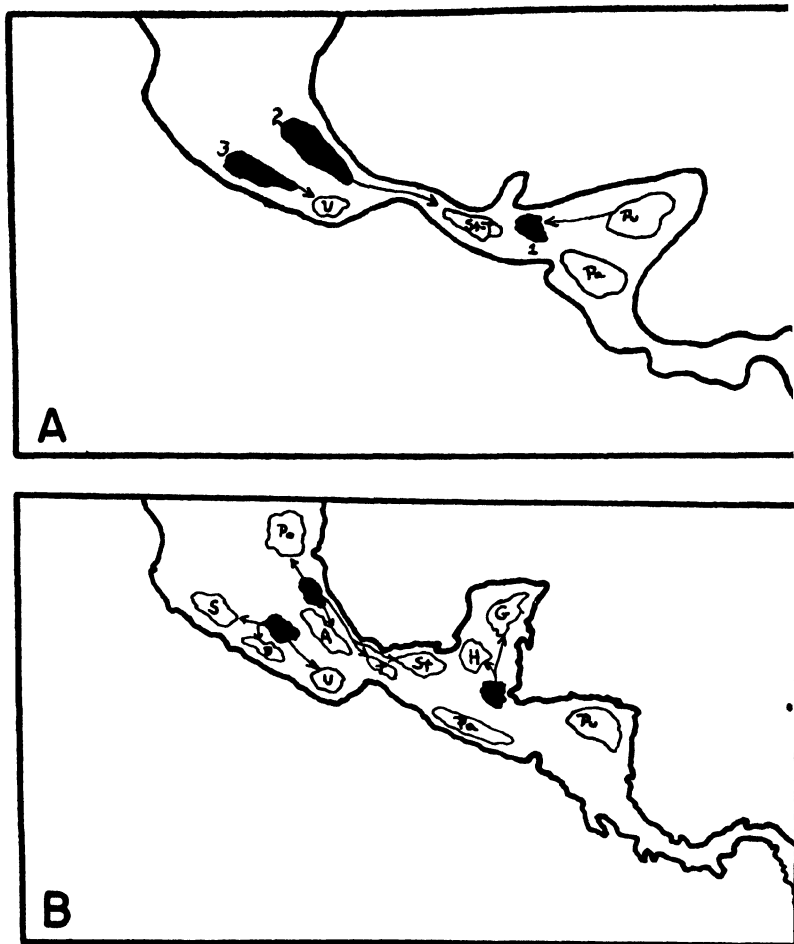


FIG. 5. Paleophylogenetic maps of *A. undulata*.
 A. Upper Pliocene and Lower Pleistocene.
 B. Upper Pleistocene and Recent.
 1. *hartwegi-gaigeae* parent stock.
 2. *podarga-amphigramma* parent stock.
 3. *dextra-sinistra* parent stock.
 A. *amphigramma*
 D. *dextra*
 G. *gaigeae*
 H. *hartwegi*
 Pa. *parva*
 Po. *podarga*
 Pu. *pulchra*
 S. *sinistra*
 St. *stuarti*
 St-T. *stuarti-thomasi* parent stock.
 T. *thomasi*
 U. *undulata*

chiefly by what was later to become *u. stuarti*, for this race is the farthest from its secondary center of dispersal. The considerable differentiation of this race—the most extensive in its group—is probably correlated with this extensive migration and relatively early separation. *A. u. undulata* (2) on the Pacific coast migrated eastward slightly, and probably its limited, though distinct, differentiation is correlated with that relatively limited migration. *A. u. parva* apparently did not move into new territory, or if so there is no indication of it in differentiation of its stock, all of which remains today as a single form. Finally (3), the pre-*gaigeae-hartwegi* stock retreated from the Palco-Yucatán Peninsula, which became largely submerged.

UPPER PLEISTOCENE AND RECENT

The major physiographic change marking this period was the emergence of the modern Yucatán Peninsula and much of the southern Atlantic border of México, in Tabasco, Campeche and Veracruz. Into this new area the pre-*hartwegi-gaigeae* stock migrated, giving rise to *u. gaigeae* in northern Yucatán and *u. hartwegi* at the base of the peninsula.

We have left in abeyance consideration of the differentiation of *u. sinistra* and *u. dextra*, and of *u. podarga*, *u. amphigramma*, and *u. thomasi*. Because of the lesser differentiation of these forms it is possible that they became distinguishable at a later time than the other races, although there is also the possibility that they merely differentiated more slowly.

In the case of *u. sinistra* and *u. dextra*, it is obvious that the arid valley of the Río Balsas effects the isolation of the two forms. We have no data on the geological history of this valley and cannot for that reason accurately correlate events in this area with those at the Isthmus. It is recorded, however, that the entire western coast of México, particularly between the Isthmus and Cape Corrientes, sank extensively after early Pleistocene times. It is possible that this depression extended the aridity of the lower basin of the Río Balsas farther into the interior, where today it penetrates even to within five or 10 miles of the extremely humid Atlantic slopes. This interpretation lends support to the idea of recent segregation of *u. dextra* and *u. sinistra*.

It appears that, like the preceding, *u. podarga* and *u. amphigramma* differentiated *in situ*. There is no prominent physiographic barrier between the areas occupied by the two races. The isolation is, in other words, ecological, and cannot well be considered any-

thing but a relatively recent one—surely as recent as the isolation of *u. dextra* and *u. sinistra*.

The origin of *u. thomasi* is somewhat perplexing. The race appears to be most closely related to *u. amphigramma*, but is separated from the latter race by *u. stuarti* which occurs in the lower Grijalva valley in Chiapas. It cannot well have arrived there before the formation of the portal, for it surely would have differentiated more extensively than it has. It may have arrived there while *u. stuarti* was migrating southward, become more or less isolated, and proceeded to parallel *u. amphigramma*. It is assumed that the early stock crossing the Isthmus southward shortly after its reformation was little different from that which gave rise to *u. amphigramma* and *u. podarga*. Isolated from pre-*u. stuarti* stock, it is not surprising that it might evolve in much the same manner as *u. amphigramma* and *u. podarga* farther north. The differences between all three lie chiefly in pattern, and it is obvious that parallelism in pattern evolution is almost universal in *A. undulata*: practically all, save *u. stuarti* tend to break up the upper lateral dark lines either by forming light spots or a continuous light line. The parallelism of *u. amphigramma* and *u. dextra* in this respect is striking, although the races presumably have no direct relationship.

SPECIALIZATION

Since most forms of *A. undulata* differentiated *in situ*, dispersal of primitive characters is not a critical problem. Determination of the primitive condition of various characters is, however, of value

TABLE 2 Specialized and Primitive Characters in *Ameiva undulata*

CHARACTERS	Primitive	Specialized
Gulars,	enlarged irregular. <i>u. pulchra</i> , <i>u. podarga</i>	a. small: <i>u. hartwegi</i> , <i>u. gaigeae</i> b. enlarged and very regular: <i>u. stuarti</i>
Prenals	2 rows	1 row
Supraocular separation.	$\frac{1}{2}$ –1*	1–2*
Upper lateral dark stripe.	unbroken, without light spots: <i>u. stuarti</i>	with light spots or stripe
Dorsolateral dark stripe .	absent	present: <i>u. stuarti</i>
Femoral pores and lamellae.	moderate number	a. reduced number: <i>u. stuarti</i> b. increased number: <i>u. hartwegi</i> and <i>u. gaigeae</i>
Dorsal spotting .	reduced or none	well developed

* The first integer refers to the length of the row of granules between the last large supraocular and the median head scales; the second integer refers to the number of rows (complete or incomplete) between the last large supraocular and the superciliaries.

in considering the few forms that did arise by migration, and in considering the extent of change in other forms.

The primitive condition of the subspecific characters in *A. undulata* are recorded in Table 2. Our decisions on them are perhaps debatable, but we feel that the evidence available preponderantly favors this arrangement.

According to that evaluation of characters, *u. pulchra* is the most primitive of group I; *u. podarga* of group III; and *u. dextra* of group IV. It is to be expected that *u. pulchra* would be the most primitive of group I, since the rest of the stock moved into an environment probably a little different from that to which the race had become accustomed.

In group III, *A. u. podarga* may have large light spots in the upper lateral dark stripe, but is otherwise primitive and is peripheral.

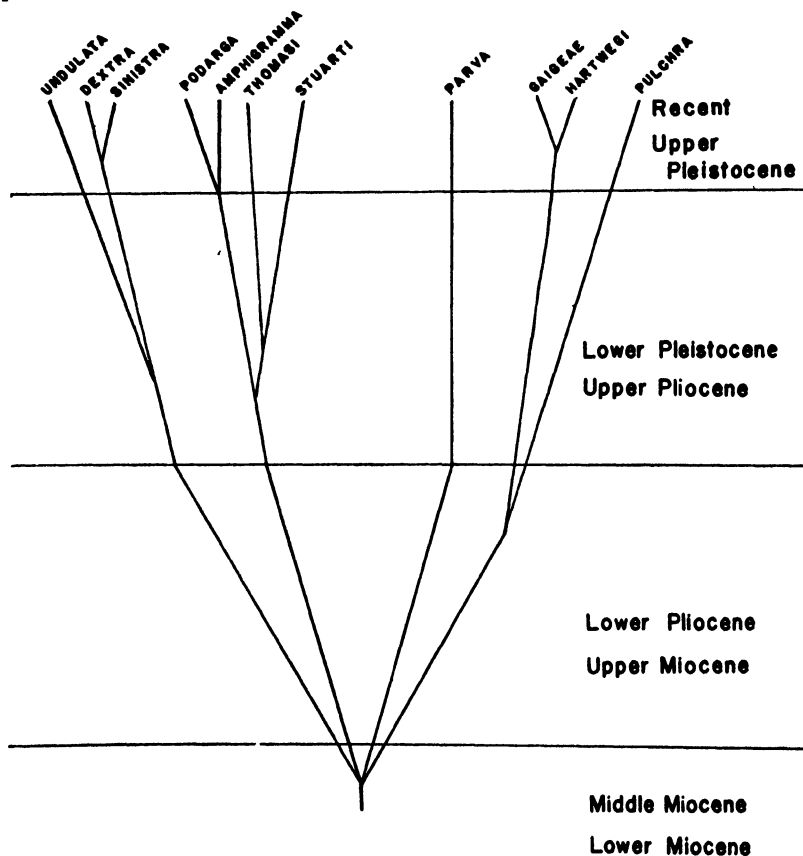


FIG. 6. Proposed phylogeny of the subspecies of *Ameiva undulata*.

With more regular gulars and a distant upper lateral light stripe, *u. amphigramma* is definitely more specialized than *u. podarga*. *A. u. thomasi* is nearly as specialized as *u. amphigramma*, and is a remarkably close parallel in spite of distinct isolation. *A. u. stuarti*, oddly enough, retains the most primitive pattern of the group or even of the species, in some respects, but combines with that a number of strongly specialized characters.

Of all members of group IV, *u. dextra* is clearly the most primitive, having only a partial specialization in preanals and no dorsal spotting, although the pattern in it is extreme in its development (very much like *u. amphigramma*). *A. u. sinistra* is more specialized in preanal arrangement, and *u. undulata* is the most highly specialized.

These relationships, and approximate time of differentiation, are indicated on Figure 6.

DIFFERENTIATION AGENCIES

Two major factors seem to have been involved in the subspeciation of *A. undulata*: isolation (1) *in situ*, due to geographical, physiological, or ecological changes; and isolation by (2) migration into new territory (see Table 3).

Before formation of the Miocene portal obviously a certain degree of differentiation correlated with migration into all available territory may have occurred, at least to such an extent that the 4 groups of *A. undulata* were slightly differentiated.

TABLE 3. Physical Factors Correlated with Subspecific Differentiation in *Ameiva undulata*

RACE OR STOCK	Physical factors
<i>pre-gaigae-hartwegi</i>	migration (from stock of group I)
<i>pulchra</i>	ecological isolation from <i>pre-gaigae-hartwegi</i>
<i>gaigae</i>	migration (from <i>pre-gaigae-hartwegi</i>)
<i>hartwegi</i>	ecological isolation from <i>gaigae</i>
<i>parva</i>	isolation
<i>stuarti</i>	migration (from stock III)
<i>thomasi</i>	migration (from stock III)
<i>amphigramma</i>	ecological isolation (from stock III)
<i>podarga</i>	ecological isolation (from stock III)
<i>undulata</i>	migration (from stock IV)
<i>sinistra</i>	physiographic isolation (from <i>pre-dextra-sinistra</i>)
<i>dextra</i>	physiographic isolation (from <i>pre-dextra-sinistra</i>)

After mechanical isolation of the four groups by the portal, differentiation then became a phenomenon accomplished (1) *in situ* (without migration), through formation of barriers here and there and resultant, partial or complete isolation; and in certain instances (2) as the species migrated into new territory also undoubtedly partially isolated, by some factor, from adjacent territory.

Those forms which migrated into new territory differentiated perhaps more extensively than those remaining in the original areas. Unfortunately there are insufficient cases at hand to demonstrate whether the migrants evolved significantly more rapidly. In fact there is little evidence that the speed of differentiation is correlated with anything but time in these lizards; the longer the isolation, the greater the differentiation. There is in all probability little difference in end result between differentiation *via* isolation and differentiation *via* migration, especially since the real factor in the latter case may in reality be isolation. There is this difference, however: that differentiation *via* migration results in a geographic trend of specialization, while differentiation *in situ* does not.

CHARACTER DISPERSAL

Peripheral dispersal of primitive characters is commonly recognized in large groups, especially of mammals, but in small groups the phenomenon is not of regular occurrence. We can verify, however, that the peripheral forms of *Ameiva undulata* do appear to be the most primitive of the species; they are *u. podarga*, *pre-dextrasinistra*, and *u. pulchra*. The reverse situation, however, occurs within the subspecies groups, which demonstrate peripheral specialization. In group I, *pre-gaigeae-hartwegi* is a peripheral specialization of earlier stock; in group III, *u. stuarti* is a peripheral specialization, again from a secondary center of dispersal; and in group IV, *u. undulata* is likewise a peripheral specialization. In each case migration into new territory, as opposed to differentiation *in situ*, has been involved.

Some explanation is in order for the apparently opposite trends of evolution of, on the one hand, the species as a whole, and on the other hand, of its subspecies groups. They appear to be fundamentally different. For migration of the species as a whole to its present peripheral range limits was accomplished with peripheral dispersal of primitive forms, while migration of lesser groups resulted in peripheral specialization.

In this particular case the apparent differences can be explained

as follows. The earliest stock of the species, as it migrated from a center of dispersal, did specialize, and the four subspecies groups at the time of their isolation were in reality specialized as compared with the original stock, none of which persisted unchanged. Reaching the limits of its range, subsequent differentiation was accomplished *in situ* only, with obviously haphazard specialization at various points in the range. Further migration occurred only centrifugally into new territories elevated near the center of the range. Actually these territories can be considered peripheral, inasmuch as they are peripheral in the ranges of the groups themselves. The secondary migration, like the first, was accompanied by peripheral specialization. The peculiar effect of having peripheral primitiveness on the one hand and peripheral specialization on the other is, then, a false illusion. In reality peripheral specialization occurred in all cases.

MIGRATION EFFECTS

Migration has, in these lizards, been the most important factor in specialization of several races. In every case of migration, specialization has followed or occurred at the same time. It can, with some degree of confidence, be suggested that migration always is accompanied by specialization in some respect, at least in these lizards. Peripheral forms may always be expected to be more specialized than their ancestral forms, although they in turn may be more primitive than other derivatives of those ancestors. If these data may be applied to Matthew's theory of peripheral dispersal of primitive groups, it is obvious that Matthew is correct only as one line of derivatives (and migrants) is compared with another line of derivatives (later migrants) of the same ancestors; his theory appears to be incorrect as applied to a single line of derivatives, in which peripheral specialization is the rule. It thus seems that the often-heard, loose statement that this Matthewsian thesis is applicable only to larger categories [each representing a different line] but not the smaller ones [each representing only one line] is, in a general way, correct and reasonable.

NONPRIMITIVE AREAS

Three areas in México are shown by this study to be newly emerged; they are the Atlantic slopes on the eastern side of the Isthmus of Tehuantepec; Pacific slopes on the western side of the Isthmus; and the northern portion of the Yucatán peninsula. All these areas were populated by relatively recent migrants. Those

which evolve at approximately the same rate as *Ameiva undulata* (most reptiles?) have not been able to use these areas as secondary centers of dispersal. Therefore, it is reasonable to postulate that, in those cases in which such animals are represented by one form in any of the three nonprimitive areas, and by one or more closely related species or subspecies in adjacent areas, the form in the non-primitive area is never the most primitive. This postulate is not to be construed to imply that relatively primitive species cannot occur there; they can and do, but if they are represented in an adjacent area by another close relative, the latter is the more primitive of the two. Likewise this postulate is not to be construed to apply to any migrants which have already set up in those areas secondary centers of dispersal from which other forms have radiated. It is believed that these areas have served as secondary centers for very few, if any, reptiles and amphibians.

AGES OF RACES

Exact ages cannot be given for any race of *A. undulata*, but because of the rather precise correlation in some cases of differentiation with geological events, the geological time estimates can give a clue to the approximate ages of the races, as indicated in Figure 6. *A. u. gaigeae* appears to be the most recent, of Upper Pleistocene date. It is also one of the least well defined of all races. Perhaps equally recent are the differentiations from each other of *u. amphigramma* and *u. podarga*, and of *u. dextra* and *u. sinistra*, but the geological correlation with the Upper Pleistocene is not so well assured as in the case of *u. gaigeae*. *A. u. stuarti* and *u. thomasi* are marked as of no greater age than that of the Upper Pliocene.

ORTHOEVOLUTION

It is pretty clearly demonstrated that the *undulata* stock can be interpreted to have evolved along one particular line with respect to pattern, all forms tending to develop light spots and later a longitudinal light line in the upper lateral dark line. Whether this extensive parallelism was effected by strong survival value of this particular type of pattern, or by a trend of mutation already established before segregation of the four groups, is not readily evident, and we hold no opinion on the basis of evidence afforded by these lizards.

PROBLEMS

Numerous problems in the systematic arrangement of Mexican *Ameiva undulata* await solution. A few are listed below.

1. Of prime interest is the status of the group containing *u. gaigeae* and *u. hartwegi*. If intergrades actually do not occur between *u. stuarti* and either of them, serious consideration should be given to the recognition of a distinct species, *Ameiva hartwegi*. In such case *gaigeae* would undoubtedly be one race of *hartwegi*, but the allocation of *u. pulchra* would remain in doubt until further studies revealed the existence or absence of intergrades between the latter and *hartwegi*. It is assumed that all the territory between these several forms is suitable for their habitation; if this actually is the case the forms must either intergrade or overlap geographically.

2. Of equal interest for future study is the possibility of intergradation between *u. undulata* and *u. amphigramma*—forms which represent two different groups not now proved to intergrade.

3. The status of *u. thomasi* is worthy of further study. It may intergrade either with *u. amphigramma* or, more probably, with *u. stuarti*.

4. Of considerable interest for future work is whether *u. parva* intergrades with *u. amphigramma*. It seems probable.

5. More material is needed to check the validity and variation in *u. dextra* and *u. sinistra*.

6. The range and geographic variation in *u. stuarti* needs further study. At present most of the recorded data are based upon specimens from a single locality.

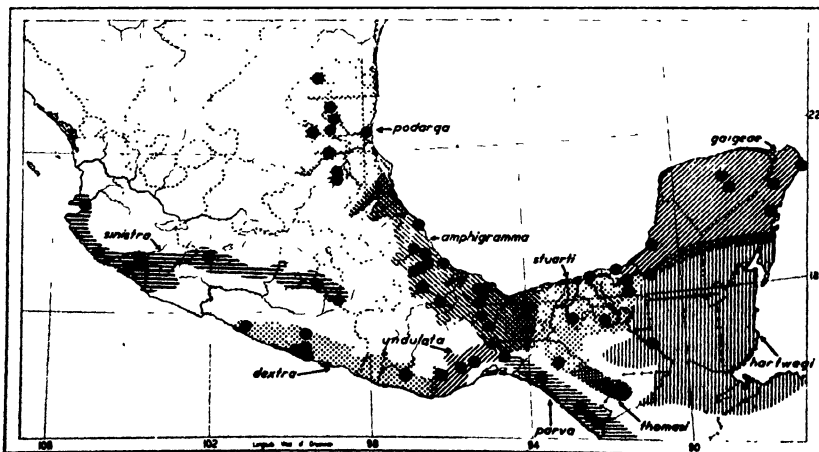
7. The color in life has been recorded for only one race, *u. amphigramma*. Detailed notes are much to be desired on live material. Undoubtedly color differences not now evident occur between a number of races. The ventral color, particularly of adult males, may prove to be of diagnostic value.

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KEY TO MEXICAN AMEIVA

1. Outer row of ventrals considerably smaller than the others.....*festiva edwardsi*.
Outer row of ventrals as large as the others..... 3
2. Preanal scales in two rows..... 3
Preanal scales in one row or with no more than one posterior scale divided..... 9
3. Two rows of granules between third supraocular and superciliaries; third supraoculars generally completely separated from frontoparietals by granules.....*u. ? a*
A single row of granules between third supraoculars and superciliaries; third supraoculars in contact with frontoparietals anteriorly..... 4
4. Median gulars abruptly enlarged..... 6
Median gulars little enlarged, gradually merging with lateral gulars..... 5
5. Upper lateral vertical light lines from axilla to groin.....*u. gargar*
12 or more
Upper lateral vertical light lines from axilla to groin
11 or less*u. hartwegi*
6. Median gulars irregular or no more than 2 regular (87%); lamellae under 4th toe 28 or more; no upper lateral light stripe, although large spots take its place in adult males*u. podarga*
At least 3 median gulars regular (100% in all except *u. amphigramma*, with 87%); lamellae variable; upper lateral light stripe present or absent..... 7
7. Dorsolateral dark stripes present except in some large adults, in which the upper lateral light spots if present are much narrower than the spaces between them; lamellae on the 4th toe usually (88%) 27 or less.....*u. stuarti*
No dorsolateral dark stripes; upper lateral light spots as wide as or wider than spaces between, or represented by a continuous upper lateral light stripe; lamellae variable 8
8. Upper lateral light spots or lines not contacting dorsolateral light area or line in adult males, separated by a narrow dark area; lateral gulars not or scarcely enlarged*u. amphigramma*
Upper lateral light spots merged with dorsolateral light line in adult males; lateral gulars markedly enlarged*u. thomasi*
9. Last preanal scale generally (86%) divided; lateral markings showing little tendency to be arranged vertically; middorsal markings greatly reduced.....*u. dextra*
Last preanal scale generally entire; lateral markings tending to be arranged vertically; middorsal markings well developed 10
10. Upper lateral light spots in adult males large, wider than intervening dark spaces; generally (95%) 5 or less rows of preanals.....*u. sinuata*
Upper lateral light spots in adult males small, narrower than intervening dark spaces in all males; frequently (65%) 6 or more rows of preanals.....*u. undulata*

FIG. 7. Distribution of subspecies of *Ameiva undulata* in México.

ACCOUNTS OF SUBSPECIES

The arrangement of these accounts follows, as closely as linear sequence will permit, the apparent phylogenetic relationships of the various forms. As explained elsewhere, we regard the group containing *pulchra* as the most primitive of *A. undulata*, even though other members of the group are rather highly specialized. Since *u. pulchra* is not Mexican it is omitted, and the list accordingly begins with *u. hartwegi* and *u. gaigeae* respectively, the latter of which obviously is a derivative of *u. hartwegi* or an ancestor very much like it. *A. u. podarga* is perhaps the least modified of trans-Isthmian forms. In geographic and partly phylogenetic sequence three other forms follow: *u. amphigramma*, *u. thomasi*, and *u. stuarti*. Whether *u. parva* or the trans-Isthmian Pacific forms should follow is an arbitrary decision; *u. undulata* and *u. parva* are about equally specialized. In deference to the rather remarkable preanal change in the more northerly group, and to the advantage of placing *u. parva* near the other races with paired preanals, we follow with the southern race. It is fairly clear that of the remaining three forms *u. dextra* is the most generalized and *u. undulata* the most specialized.

Ameiva undulata hartwegi Smith

(Pl. 2, Fig. B)

Ameiva undulata hartwegi, Smith, 1940: 55 (type locality Chiapas, México, across the Rio Usumacinta from Piedras Negras, Petén, Guatemala; type U. S. Nat. Mus. No. 108600).

When originally diagnosed this form was conceived to be more or less homogeneous, ranging throughout the Yucatán Peninsula and its base, including the Petén area of Guatemala. This interpretation was likewise held by Stuart (1942: 145). Both authors observed chiefly the uniformity of the character of the gular scales throughout this area, Stuart extending its range as far as Honduras. Since the character is so peculiar in the species *Ameiva undulata* it is not surprising lesser geographical variations received little attention. It is well known, however, that a very large percentage of wide-ranging species, whose ranges include the entire Yucatán Peninsula, have differentiated in such a way that a northern Yucatán race is distinguishable. Examination of specimens from northern and southern extremes revealed that differences occur in this form, as well as in many others.

Diagnosis. *A. u. hartwegi* as at present defined may be diagnosed as follows: gulars small and irregular, preanals in two rows; lam-

ellae on 4th toe 29 or more (100%), generally 31 or more (81.5%) femoral pores on both sides 39 or more (89.8%), upper lateral vertical light lines between axilla and groin 11 or less (98.2%). The last two characters differentiate this race from *u. gaigeae*, comparisons with which are given in Table 7.

Range. Atlantic slopes of México and Guatemala from the vicinity of the southeastern end of Laguna de Términos south and eastward across the base of the Yucatán Peninsula to northwestern Honduras.

TABLE 4 Variation in *A. u. hartwegi*

CHARACTER		Counts	Range	Average
Femoral pores, one side	♂ ♂	62	17-23	20.9
	♀ ♀	38	16-22	19.9
Femoral pores, total	♂ ♂	30	37-45	41.9
	♀ ♀	19	34-41	39.7
Lamellae on 4th toe		97	29-36	31.8
Upper lateral vertical light lines from axilla to groin		5	8-12	9.6

Locality records. We have examined 78 specimens from the type locality, and from Piedras Negras, Petén, Guatemala. We have taken data on only fifty of this series. We are aware of no other locality records for México.

Discussion. This is the largest of Mexican races of *Ameiva un-*

TABLE 5 Comparisons of *A. u. hartwegi* with *A. u. stuarti*

CHARACTER	<i>hartwegi</i>	<i>stuarti</i>
Femoral pores	18 or more 98%	17 or less 97.3%
Lamellae on 4th toe	29 or more 100%	28 or less 98.6%
Gulars	small irregular	large regular

dulata, reaching a maximum size of 138 mm snout to vent in males, and 115 mm. in females. Variation in femoral pores, lamellae on fourth toe and upper lateral light lines are given in Table 4.

Comparisons. The only forms in México with which *u. hartwegi* intergrades are *u. gaigeae* and possibly *u. stuarti*. Comparisons with the latter are given in Table 5, with the former in Table 7. The intergrades are discussed with the other species.

Ameiva undulata gaigeae subsp. nov.*

(Fig. 1C; Pl. 2C)

Holotype. An adult male, EHT-HMS No. 11927, from Progreso, Yucatán, collected by Hobart M. Smith, 1935.

Paratypes. Sixty-three, including 6 topotypes (EHT-HMS Nos. 11925-6, 11928-31), fifty-nine (EHT-HMS No. 11985, UMMZ Nos. 6821 72934-72957, 80847-80860, 80861 (3), 80862 (5), 83289 (3), 8089 (5)) from Chichén Itzá, Yucatán; three (UMMZ No. 78586 [3]) from a locality five miles inland from Vigía, Quintana Roo; and two (UMMZ No. 78587[2]) from Ascención Bay, Yucatán.

Locality records. All specimens available have been included in the type series, except UMMZ Nos. 68216-68224, from Chichén Itzá, all juveniles; UMMZ No. 83535, from Ciudad del Carmen, Campeche; EHT-HMS No. 11942-11945, 13114, from Encarnación, Campeche (intergrades with *u. hartwegi*); and UMMZ No. 83945, from Cobá, Quintana Roo. The U. S. National Museum has specimens (not seen) from La Vega, Mujeres Island, and Tunkas, Yucatán. Gaige (1936:297) reports it from Champotón, Campeche.

Diagnosis. Related to *u. hartwegi*, having small, irregular gulars and preanals in two rows. Differs from that form in having 12 or more (89.5%) lateral vertical light spots between axilla and groin, and in having fewer femoral pores (in males, 19 or less on one side [61%], 40 or less on both sides [77.5%]; in females, 18 or less on one side [76%], 37 or less on both sides [82%]).

Description of type. Head scales typical of *Ameiva undulata*. Frontoparietals very narrowly in contact with second supraocular; 3 supraoculars, followed by a group of 3 enlarged granules; 2 frenoculars; an incomplete secondary row of small scales in addition to the primary between posterior chin shields and infralabials; central gulars irregular, small, one-half or one-third size of largest mesoptychial, about 2 or 3 times as large as adjacent lateral scales; mesoptychials relatively small, no larger than scales in anterior row of abdominals; 32 rows of ventrals; 6 rows of preanals, paired; femoral pores 17-18; lamellae on fourth toe 30-31.

Dorsal ground color dull, bluish slate; middorsum with small, irregular, dark spots posteriorly, none on neck or scapular region; dorsolateral dark stripes and dorsolateral light stripes completely

* Named for Mrs. Helen T. Gaige of the Museum of Zoology, University of Michigan, in recognition of her contributions to the knowledge of the Yucatán herpetofauna and to the guidance of many students whose good fortune it has been to be hers. It is a pleasure to associate her name in one genus with that of her closest professional colleagues, Drs. Norman Hartweg, Alexander Ruthven and L. C. Stuart.

absent; upper lateral dark area split into numerous transverse spots, separated from each other by 18 vertical light blue lines from axilla to groin, nearly or quite equal in width to the dark spots; lateral light line indicated by a series of small light spots, one at the ventral end of each of the vertical light lines previously mentioned; sides dimly barred, the lines for the most part tending to coincide with those in the upper lateral zone; hind legs with an ill-defined, open, dark reticulation and with small, scattered, light spots, especially on the shank.

Variation. The males resemble the type very closely, varying chiefly, so far as pattern is concerned, in the amount of spotting on

TABLE 6 Variation in *A. u. gargar*

CHARACTER		Counts	Range	Average
Femoral pores, one side	♂♂	80	15-22	19.1
	♀♀	58	15-21	17.6
Femoral pores, both sides	♂♂	40	31-43	38.1
	♀♀	28	31-42	35.3
Lamellae on 4th toe		132	26-36	30.4
Upper lateral vertical light lines from axilla to groin		57	9-18	13.1

the back. The number of vertical light lines in the upper lateral area also varies somewhat as indicated in Table 6. In all the upper lateral spots are clearly defined.

Females, at least in the young and half-grown specimens, possess fairly distinct dorsolateral light lines; the upper lateral dark area is split by dim light lines forming a pattern similar to that of the males, but much less distinct; the lateral light line is more clearly evident than in the males, although it still consists of spots and short lines; the sides below the level of the lateral lines are very feebly marked. On the whole, females are readily distinguishable from males by the emphasis in them of the longitudinal elements of the pattern.

The gulars vary somewhat in size and arrangement, but in very few specimens are any central gulars abruptly enlarged. In occasional specimens there is a tendency toward alignment of the central gulars in a single, median row, but the scales are no larger than in other specimens.

The largest male measures 125 mm. snout to vent; the largest female 107 mm.

Variation in femoral pores, lamellae on the 4th toe, and the number of upper lateral light lines is given in Table 6.

(Comparisons. The present race is distinguished from the west coast forms except *u. parva*, by a double row of preanals, and from all others, save *u. hartwegi*, by the small, irregular gulars. It differs from *u. hartwegi* as shown in Table 7.

Intergrades between *u. hartwegi* and *u. gaigeae* are available from Encarnación, Campeche (EHT-HMS 11942-5, 13114). These five specimens are all large females measuring between 95 mm. and 108 mm., snout to vent. The gulars are completely irregular and rela-

TABLE 7 Comparisons of *A. u. gaigeae* and *A. u. hartwegi*

CHARACTER		<i>gaigeae</i>	<i>hartwegi</i>
Femoral pores, one side	♀ ♀	19 or less 75 9%	19 or more 92 1%
	♂ ♂	19 or less 61 2%	20 or more 90 3%
Femoral pores, both sides	♀ ♀	37 or less 82 1%	38 or more 89 5%
	♂ ♂	40 or less 77 5%	41 or more 73.3%
Upper lateral vertical light lines from axilla to groin		12 or more 89 5%	11 or less 98 2%

tively small; lamellae on the fourth toe vary from 29 to 32 (29, one; 30, four; 31, four; 32, one); femoral pores 15 to 19 (15, one; 16, one; 17, one; 18, three; 19, four); upper lateral light spots between axilla and groin 10 to 14 (10, two; 12, one; 13, one; 14, one).

These specimens cannot be referred to *u. stuarti*, nor do they more than slightly resemble it; in practically every respect they differ from that form. Therefore, we need consider only *u. hartwegi* and *u. gaigeae*. In pattern, one of the chief differential characters, they are intermediate, but perhaps nearer *u. gaigeae*; and in number of femoral pores they are fairly close to *u. gaigeae*. The large size is more typical of *u. hartwegi*, although the difference is slight; one specimen exceeds by 1 mm. the maximum known for typical *u. gaigeae*. For the present we prefer to allocate the population represented with *u. gaigeae*.

Range. Northern half of the Yucatán Peninsula, and southward to the island of Carmen along the extreme eastern coast. Intergrades with *u. hartwegi* occur at least east of Laguna del Carmen, and probably northward through the central part of the peninsula where the high forest meets the coastal scrub. Intergradation with *u. stuarti* probably occurs in areas near the eastern end of Laguna del Carmen.

Ameiva undulata podarga * subsp. nov.

(Figs. 1D, 2A)

Holotype. An adult male, EHT-HMS No. 14471, from 7 miles west of Victoria, Tamaulipas, collected by Hobart M. Smith and David H. Dunkle, 1934.

Paratypes. Fifteen, including 5 (EHT-HMS Nos. 14472-4, USNM Nos. 106141-2) from Hacienda La Clementina, near Fonnón, Tamaulipas; 3 (EHT-HMS Nos. 11959-61) from Antiguo Morelos, Tamaulipas; 2 (UMMZ No. 88232 [2]) from Río Guayala near Magiscatzin; 3 (EHT-HMS Nos. 11677-9) from near Ciudad Maiz, San Luis Potosí; one (EHT-HMS No. 11962) from near Valles, San Luis Potosí; and one (HMS No. 1597) from Huichihuayán, San Luis Potosí.

Diagnosis. Related to *u. amphigramma* and *u. stuarti* having paired preanals, abruptly enlarged gulars, and the last supraocular broadly in contact with median head scales and separated from the superciliaries by a single row of granules. Differs from *u. amphigramma* chiefly in the absence of the upper lateral light stripe and in reduction of spotting, but also in having completely irregular gulars or no more than two regular median scales (84.6%). Differs from *u. stuarti* in having irregular gulars, lamellae on the fourth toe twenty-eight or more (100%), presence of large upper lateral light spots in males, and in the absence of a dark median border on the dorsolateral light stripe.

Description of type. Head scales similar to the type of *u. dextra* except as follows: chin shields separated from posterior infralabials by a single row of small scales; central gulars enlarged, irregular, except for two broad scales in the median line; enlarged mesoptychials in two rows; 32 ventrals from gular fold to preanal region; five rows of preanals, paired; femoral pores 17-18; lamellae on fourth toe 29-29.

Snout to vent, 102 mm.; tail broken; hind leg, 77 mm.; foreleg, 36 mm.; snout to gular fold, 35.5 mm.; snout to anterior margin of ear, 24 mm.

Middorsum slate gray; very few small scattered dark spots on posterior part of back; dorsolateral light line dimly evident on neck, not elsewhere; below the level of the dorsolateral light line a series of large subquadrangular, light spots, separated from each other by narrow, dark brown bars, half as wide as the light spots; sides

* From Greek, swift-footed.

lighter brown, traversed by numerous, narrow vertical, broken or continuous, light streaks which extend from the belly almost or quite to the level of the upper lateral light spots; gular region bluish, belly darker.

TABLE 8. Variation in *A. u. podarga*

CHARACTER	Counts	Range	Average
Femoral pores, one side....	14	15-18	16.8
	17	13-17	15.3
Lamellae on 4th toe.....	30	28-31	29.4
Rows of gulars ..	16	5-7	5.7

Variation. Six males are available, all adults except two juveniles, one measuring 48 mm. snout to vent, the other 36 mm. All specimens (save the smallest in which the upper lateral light spots are present but very dim) clearly show markings similar to those of the type, with no tendency whatever of the lateral light spots to fuse, forming a stripe. The spots are, in all, separated by dark bars at least half as wide as the light spots, usually wider. As in the type the middorsum is practically immaculate. The sides are dimly marked in all except the largest male (HMS 1597) which has a distinct, broken lateral light line as well as vertical, lateral light lines; in it also the dorsolateral light lines are distinct, while in the others they are very dim.

Females are very much like the males; the middorsal markings are somewhat better developed; the dorsolateral light stripes are somewhat clearer; the upper lateral light spots are absent in the young, but appear dimly in specimens measuring about 80 mm. or more, and in some specimens closely approach the condition in the males. The lateral light stripe is well developed in the young and is usually retained in the adults, but may disappear (1 specimen). Even to a greater extent than in the males the lateral light markings are reduced in number, size and distinctness.

The largest male measures 116 mm. snout to vent; the largest female 96 mm.

Variation in femoral pores and lamellae are given in Table 8. The central gulars are irregular in arrangement; in six specimens they are completely irregular, no two scales being alike and situated in the median line; in 5 specimens a maximum of two scales are medially situated, and in two specimens all the enlarged central gulars but one (in a total of five) are regularly arranged.

Comparisons. The race of *Ameiva undulata* nearest to *u. podarga* both geographically and, presumably, taxonomically is *u. amphigramma*. There are few differences between the two races except in gulars and pattern. The pattern differences are, however, very striking and include, as the most important, the development of the upper lateral light stripe. In *u. amphigramma* this stripe is, in males, either continuous (the usual condition) or broken into blotches, separated from each other by very narrow dark lines, considerably less than half the width of the blotches. This condition obtains in males of all sizes but increases in distinctness with age. Oddly enough in the females either a continuous or discontinuous upper lateral light stripe similar to that of the males only much dimmer, is developed in adult specimens; unlike the males, however, juvenile females do not show the stripe or spots.

TABLE 9. Comparisons of *A. u. podarga* with *A. u. amphigramma*

CHARACTER		<i>podarga</i>	<i>amphigramma</i>
Femoral pores, one side..	♂♂	average 16.8	average 17.6
	♀♀	15 or less 64.7%	16 or more 75.0%
Gulars (based on the largest 5 median scales)		irregular or no more than 2 regular 86.7%	regular or no more than 3 irregular 87.3%
Pattern	mottling	reduced	well developed
	upper lateral light stripe	absent or represented by spots less than twice width of intervening spaces	present or represented by spots over twice width of intervening spaces

In *u. podarga* the upper lateral light stripe is never continuous but is represented by large light blotches separated from each other by dark spaces at least half as wide as the light areas. As in *u. amphigramma* this pattern occurs in all males and in adult females with the same limitations.

In *u. amphigramma* the body and legs are rather strongly spotted; the markings are most distinct on the middorsum and, with the exception of adult males, on the legs. In *u. podarga* on the other hand, the back and legs are practically unicolor, and as described for both sexes, the sides have very little spotting.

There is some difference in the average number of femoral pores of these two races as indicated in Table 9, but the character is not of taxonomic value, except perhaps in females. Further data are

required on this point. There is also an apparent difference in the number of rows of sublabials between the posterior infralabials and the chin shields, although again the difference appears to be of little taxonomic value. In *u. podarga* eight specimens have only one row, five have an incomplete secondary row, while one has a short, complete secondary row.

The arrangement of the median gulars is a character of considerable importance in separating *u. podarga* and *u. amphigramma*. In the former 86.7 percent of the specimens have completely irregular or no more than two regular median scales (restricting to five the number of gulars considered); in *u. amphigramma* only 12.7 percent are of that character.

TABLE 10 Comparisons of *A. u. podarga* with *A. u. stuarti*

CHARACTER		<i>podarga</i>	<i>stuarti</i>
Lamellae on 4th toe		28 or more 100%	27 or less 87.5%
Gulars (Based on the largest 5 median scales)	arrangement	irregular or no more than 2 regular 86.7%	regular or no more than 3 irregular 100%
Pattern	upper lateral light spots	present, broad	absent or narrow
	dorsolateral dark stripe	always absent	present except in some adults
	dorsolateral light stripe	faint or absent	well developed

Comparisons of *u. podarga* with *u. stuarti* are given in Table 10. The differences as cited in the table are self-explanatory.

Range. Aside from the localities represented by the paratypes, we have records of specimens from the following: *San Luis Potosí*: Tamazunchale (EHT-HMS); *Tamaulipas*: Alta Mira (USNM); Victoria (USNM). The range appears to extend along the Atlantic coast from the latitude of Victoria, Tamaulipas, southward into northern Veracruz. The exact area of intergradation with *u. amphigramma* is unknown at present.

Ameiva undulata amphigramma Smith and Laufé

(Pl 1, Figs C, D)

Ameiva undulata amphigramma Smith and Laufé, 1945: (type locality San Andrés Tuxtla, Veracruz, type EHT-HMS No 11983)

Diagnosis. A member of the *undulata* group of *Ameiva*, closely related to *u. stuarti* and *u. podarga*; preanals in two rows; median gulars rather abruptly enlarged, arranged generally in a median row

of 5 to 8 scales. Differs from *u. podarga* in having (1) usually ($\frac{1}{2}$ %) no more than 2 of the 5 largest gulars divided or irregular, (2) usually (75%) 16 or more femoral pores in females; (3) considerable mottling on the back, and (4) an upper lateral light stripe which is never or rarely broken into light spots less than twice as wide as the dark intervening spaces. Differs from *u. stuarti* to some extent in number of lamellae under the fourth toe (55% with 28 or more), and in having fewer gulars of which more are irregular, but chiefly in pattern: (1) Adult males possess a conspicuous, broad, longitudinal, light, upper lateral stripe which may be broken into large spots not less than twice the width of intervening spaces; this character is discernible although indistinct in adult females, and is generally at least feebly evident in young males; (2) there is no continuous dorsolateral dark stripe, typically, although females may have it broken into spots or reduced in length or width; and (3) the dorsolateral light stripes completely disappear in adult males. Differs from *u. stuarti* and *u. gaigeae*, the only other races with two rows of preanals, chiefly in the possession of the upper lateral light stripe, abruptly enlarged gulars, and a smaller maximum size.

Range. Northern Veracruz (exact area uncertain, perhaps in the vicinity of Laguna Tamiahua, where it intergrades with *u. podarga*, southward at relatively low elevation (below about 4,000 ft.) through most of Veracruz to the Isthmus of Tehuantepec, there intergrading with *u. stuarti*; westward into valleys extending into extreme eastern Oaxaca and probably northeastern Puebla.

Localities. We have now examined a total of 104 specimens of this race. Localities represented by specimens examined include: *Veracruz*: Atoyac, Boca del Río, Cuatotolapam, Lake Catemaco, Jalapa, Orizaba, Potrero Viejo, Puente Nacional, Rodriguez Clara, San Andrés Tuxtla, Tierra Colorada; *Oaxaca*: Cosolapa, Matías Romero. Literature records include Achotal, Hda. del Hobo, Jicaltepec, Mirador, Obispo, Otopa, Perez and Presidio in *Veracruz*, and Agua Fria, *Oaxaca*. The U. S. National Museum has specimens (not seen) from Tuxtepec, *Oaxaca*, San Rafael, *Veracruz*, and La Venta, *Tabasco*.

Discussion. Two additional topotypes (EHT-HMS Nos. 15136-7), from San Andrés Tuxtla, Veracruz, have come to hand since the form was described. One is a juvenile male measuring 54 mm. snout to vent; it shows a dark dorsolateral stripe typical of *u. stuarti* and never present in more northern *u. amphigramma*; the lamellae on the fourth toe, however, number 30-32, as is characteristic of *u. amphigramma*.

The other specimen, an adult male, has large upper lateral spots separated from each other by vertical dark bars generally less than half the width of the light areas; its lamellae on the fourth toe number 29-29. In both these characters it resembles *u. amphigramma*.

TABLE 11. Variation in *A. u. amphigramma*

CHARACTER		Counts	Range	Average
Femoral pores, one side	♂♂	88	14-23	17.6
	♀♀	92	11-20	16.4
Lamellae on 4th toe		187	24-33	27.7
Rows of gulars		95	5-8	5.9

While the type and two paratypes, all adult males, from this same locality have the typical pattern of *u. amphigramma*, they do have fewer lamellae (27-28, 27-?, 27-28) than most *u. amphigramma*, but like most (88%) *u. stuarti*.

These five specimens as a group definitely appear to represent an intergrading population between these two races. The most outstanding feature of *u. amphigramma*, the pattern, is apparently typical of the population.

It is unfortunate that the type locality lies within an area of intergradation, but obviously the intergrades approach the northern race, which we defined and intended to name, much more closely than the southern (*u. stuarti*).

Thirty-three specimens from very near the type locality, at Cuatotalapam (UMMZ 41422-41442, 41444-41454) and Lake Catemaco (UMMZ 41443), Veracruz, agree well with the types in pattern. There are 16 males, of which all but one are of large or moderate size. The smallest (43 mm. snout to vent) shows only faint evidence of a dorsolateral dark band (in the neck region), and has a faint upper lateral light stripe. In the other males, nine have continuous upper lateral light stripes, and five have the stripes broken by a few very narrow dark lines. In one the upper lateral light spots are small and separated from each other by dark spaces as broad as the light spots, or broader. Of the seventeen females, nine show evidence of an upper lateral light stripe; all these are 67 mm. or more in snout-vent length. The other females, which lack any evidence of an upper lateral light stripe, are smaller, 70 mm. or less in snout-vent length. Two show a fairly distinct dorsolateral dark stripe, but no other specimens, male or female, possess them,

even though one female measures only 38 mm. snout to vent. Many females do, however, possess numerous dark spots which may represent the dorsolateral dark stripe, since they border the dorsolateral light stripe medially. This lot of specimens approaches *u. stuarti* in some characters, as in the occasional presence of a dorsolateral dark stripe and in a reduced number of fourth toe lamellae. There is no question whatever, on the other hand, that they represent a population essentially like *u. amphigramma*, and but little diluted by *u. stuarti*. An excellent description of the color in life of this series is given by Ruthven (1912: 320-322), who calls attention to the distinct upper lateral light stripe in males.

The two juvenile paratypes from Matias Romero, Oaxaca, have the low lamellar count (24-24, 27-27) of *u. stuarti*, although in other respects they are typical of *u. amphigramma*. This may indicate an intergradient character for this population.

Four specimens (EHT-HMS 11955-8) from Rodriguez Clara, Veracruz, some 70 kilometers south of the type locality, probably can also be considered as intergrades. The single adult is a female with relatively large upper lateral light spots, which are to be sure narrower than the dark spaces between them, but on the other hand broader than in typical *u. stuarti*. The other three specimens are juveniles with the typical paradorsolateral dark stripes of *u. stuarti*. The lamellae on the fourth toe are intermediate between the expected counts: Two have 29-29, 29-?, as in the northern race, while the others have 26-26, 27-27 as in the southern. In view of the pattern of the female, the intermediate nature of the lamellar counts, and the expected pattern of adult males as based on specimens known from the nearby type locality, we allocate the specimens, tentatively, to *u. amphigramma* although the population represented is undoubtedly an intergrading one.

Forty-four other specimens from central Veracruz at Matacabresto (UMMZ No. 88647), the vicinity of Potrero Viejo (UMMZ Nos. 85407 (5), 85408 (13), 85409 (4), 88648-9, 89325, EHT-HMS No. 19582), and Tierra Colorada (EHT-HMS Nos. 11968-76, 11978-81), have been examined since the original description was written. They are essentially similar to those previously recorded and described from this area.

The largest specimens examined measure 101 mm. in females, 105 mm. in males.

The extreme southeastern record for the race is one now to be considered dubious. It consists of a single specimen (USNM

TABLE 12. Comparisons of *A. u. amphigramma* with *A. u. stuarti*

CHARACTER		<i>amphigramma</i>	<i>stuarti</i>
Lamellae on 4th toe.....	.....	28 or more 54.6%	27 or less 87.5%
Pattern.....	dorsolateral dark stripe	absent	well developed
	upper lateral light stripe	present or represented by spots over twice width of intervening spaces	absent or spots very narrow
Gulars.....	No. of rows	6 or less 76.5%	7 or more 56.9%

117350) recorded by Smith (1944) from La Venta, fifteen miles southeast of Tonalá, Tabasco. This specimen, not reexamined, is said to have 21-21 femoral pores and 30-32 lamellae. Such counts do occur in *u. amphigramma*, but not in *u. stuarti* to our knowledge, in which 18 femoral pores and 30 lamellae are the recorded maximum. We accordingly refer it tentatively to the former race.

Comparisons. Variation and comparisons with *u. stuarti* are given in Tables 11 and 12.

*Ameiva undulata thomasi** subsp. nov.

(Pl. 1, Fig. A)

Holotype. Adult male, EHT-HMS No. 15327, from La Libertad, Chiapas, near Río Cuileo where it crosses the Guatemalan border; collected by Henry D. Thomas.

Paratypes. Eight, including seven topotypes (EHT-HMS Nos. 15323-15326, 15328-15330) and one labeled "Chiapas" and probably from the same locality (EHT-HMS 15374); all collected by Henry D. Thomas.

Diagnosis. A member of the *undulata* group possessing paired preanals, abruptly enlarged gulars, lacking a secondary row of superciliary granules, and with supraoculars broadly contacting the frontoparietals. The adult male pattern differs from that of all other forms of *A. undulata*, in having the upper lateral light spots merged with the dorsolateral light line to form a continuous light band, the dorsal border of which is regular, the ventral irregular and giving rise to the vertical light bars. Possibly differs from *u. stuarti*, the most closely related form, in having more numerous lamellae under the fourth toe (75.5% with more 28 or more). Differs from all other races in that the extreme lateral gulars are enlarged.

* Named for its collector, Henry D. Thomas, who also was a field companion of the senior author in México during the summer of 1936.

Description of type. Scutellation typical except as below: Three supraoculars, the posterior two separated from the superciliaries by a single row of granules; central gulars normal with a regular median row of abruptly enlarged scales; lateral gulars enlarged; largest mesoptychial narrower but longer than largest median gular, approximately the same area; 32 ventrals from gular fold to preanal region; six rows of preanals each consisting of paired scales; femoral pores 20-20; lamellae under fourth toe 29-29.

Snout to vent, 82 mm.; tail regenerated; hind leg, 57 mm.; fore-leg, 29 mm.; snout to gular fold, 29 mm.; snout to anterior margin of ear, 21 mm.

Middorsum bluish-gray, flecked with very small, lateral dark spots which tend to form two rows, beginning on rump and disappearing at the level of the shoulders; dorsolateral dark stripe faintly evident, bordered laterally by a broad continuous light line formed by the merging of the dorsolateral light line with the upper lateral light spots between the axilla and groin; anterior to the level of the shoulder the dorsolateral light line continues, normal in width, to the posterodorsal border of the eye; the ventral border of the broad light line is irregular, giving rise to short, light vertical bars which are half as broad as the intervening dark spaces or less; ventrally the vertical light lines meet the lateral light line which is occasionally broken. Ventrums discolored.

Variation. Males show some variation in the dorsolateral light band. In one specimen the pattern is completely typical; in the other two, the upper lateral light spots have merged with the dorsolateral light line, which is very narrowly broken at irregular intervals. In all three the dorsal mottling closely resembles that of the type, and the upper vertical light lines are one-half as broad as the intervening dark spaces or less.

In the five available females, in all but one the lateral light spots are greatly reduced and only faintly evident. In these four specimens, there appears to be no tendency whatever of these spots to merge with the dorsolateral light line which is completely distinct. In the other specimens the upper lateral light spots are well developed anteriorly and medially, laterally fusing with each other but narrowly separated from the dorsolateral line; posteriorly they are reduced as in the other females. In all specimens the dorsolateral dark line is faintly evident and the lateral line is broken into a series of small, rounded or ovoid light spots. In all but one specimen, in which it is well-developed posteriorly, the dorsal mottling resembles that of the males.

TABLE 13. Variation in *A. u. thomasi*

NUMBER	Sex	Femoral pores	Lamellae under 4th toe
15323	♀	16-18	26-?
15324	♀	16-17	27-29
15325	♂	16-17	28-29
15326	♀	14-16	30-30
15327	♂	20-20	29-29
15328	♀	16-18	25-26
15329	♀	16-16	29-29
15330	♂	17-19	29-30
15374	♂	18-19	28-29
Average	♂, ♀	17.2	28.4

The largest male measures 92 mm. snout to vent, the largest female 78 mm.

Variation in femoral pores and lamellar counts are given in Table 13. The central gulars are abruptly enlarged and arranged in a single median row in all the specimens. In only one male one of the median gulars is split. All the specimens possess the enlarged lateral gulars.

Comparisons. The present race is distinguishable from *u. dextra*, *u. sinistra*, and *u. undulata* in its possession of a complete double row of preanal scales; from *u. parva* in lacking an accessory row of granules between the supraoculars and superciliaries; from *u. hartwegi* and *u. gaigeae* in possessing abruptly enlarged median gulars; and from *u. podarga* in possessing regular median gulars. From *u. amphigramma* and *u. stuarti*, its closest relatives, and all other Mexican forms of *Ameiva undulata*, *u. thomasi* differs in having the upper lateral light spots merged with the dorsolateral light lines to form a continuous broad light line. Possibly the present race also differs from *u. stuarti* in having more lamellae under the 4th toe (28 or more 76.5%). Another character of considerable importance separating *u. stuarti* and *u. thomasi* is the nature of the dorsolateral dark stripes. In the former they are well developed, only very faintly evident in the latter. Although in most scutellation characters *u. thomasi* resembles *u. amphigramma*, the difference in the make-up of the broad light line coupled with the geographic isolation of the two forms from each other warrants segregation. Comparisons with *u. stuarti* are given in Table 14.

Range. The race probably occurs in all the dry, hot valleys of the upper tributaries of the Río Grijalva in the interior of Chiapas and of western central Guatemala.

TABLE 14. Comparisons of *A. u. thomasi* with *A. u. stuarti*

CHARACTER		<i>thomasi</i>	<i>stuarti</i>
Lamellae under 4th toe,		28 or more 76.5%	27 or less 87.5%
Pattern.....	dorsolateral dark stripes	reduced	well developed
	upper lateral light spots in males	present, fused with dorsolateral light line	absent

Localities. We have seen specimens only from the type locality, but Stuart (1943: 21) records a specimen, referred to *A. u. stuarti*, from Nentón, Guatemala, which undoubtedly belongs to this race. We know of no other localities.

Ameiva undulata stuarti Smith

(Fig 1B; Pl. 1, Fig B)

Ameiva undulata stuarti Smith, 1940 55-56 (type locality Palenque, Chiapas, type U. S. Nat. Mus. No. 108601).

Diagnosis. The salient features of this race include the small size, the paired preanals, the single row of abruptly enlarged, numerous (6-8) median gulars, the reduced number of lamellae on the fourth toe (22-30, average 25.5, 27 or less 87.5%) and of femoral pores (13-18, average 15.5, 17 or less 97.3%), and the presence of well-defined dorsolateral dark stripes (except in some adults). There are no upper lateral light stripes or spots.

Range. Atlantic slopes of México from the middle of the Isthmus of Tehuantepec eastward in the lowlands to the southern borders of Laguna de Términos and to Tenosique, Tabasco; southward up the valley of the Río Grijalva at least as far as Tuxtla Gutiérrez, Chiapas.

Localities. We have examined 107 specimens from Palenque and San Ricardo, Chiapas; Tenosique, Tabasco; Balchacaj and Tres Brazos, Campeche. We have taken data on most of this series. Records for other localities include Frontera and Teapa, Tabasco (USNM).

Discussion. Variation in femoral pores, lamellae on the fourth toe, and in the central gulars is given in Table 15.

TABLE 15. Variation in *A. u. stuarti*

CHARACTER		Counts	Range	Average
Femoral pores, one side.....		73	13-18	15.5
Lamellae on 4th toe.....		72	22-30	25.5
Gulars.....	No. of rows	58	6-8	6.7
	No. of scales regular	58	3-8	6.1

This race possibly intergrades with *u. hartwegi* and *u. gaigeae* toward the west (see Table 5). Intergrades with *u. amphigramma* are discussed with that form (Table 12).

In spite of the close proximity of localities from which *u. hartwegi* and *u. stuarti* are known, we have seen no incontrovertible intergrades between the two. If intergradation does occur, it must be restricted to a very narrow belt. There appears to be a sharp difference in ecological preference, *u. stuarti* preferring the mixed scrub-savanna coastal areas, while *u. hartwegi* prefers the dense, high, inland forests. The specimens from Campeche do approach *u. hartwegi*, since the dorsolateral dark stripes are somewhat variable; otherwise the specimens are typical. Eastward, southeastward, and probably southward also, it meets *u. hartwegi* in the dense inland forests and foothills. Toward the west it meets *u. amphigramma* near the isthmus of Tehuantepec which presumably is occupied by intergrades. The specimens from San Ricardo indicate the extension of the race up to the valley of the Río Grijalva into the lower portion of the Chiapas plateau. No trend whatever toward *u. parva*, which occurs not far from San Ricardo across the Sierra at Tonalá, is evident in these specimens, which include an adult male and female, and a juvenile male. There is no visible approach toward the characters of *u. thomasi*, although intergrades may well occur.

Ameiva undulata parva Barbour and Noble

(Fig. 1A; Pl. 2, Fig. A)

Ameiva undulata parva Barbour and Noble, 1915: 476-477 (type locality Guatemala, here restricted to Mazatenango; type MCZ No. 5831).

Diagnosis. This race, possibly the most ornate of Mexican forms, is characterized by having paired preanals, a median row of about 6 or 7 abruptly enlarged gulars, generally a complete or incomplete accessory row of granules between supraoculars and superciliaries, generally the third supraocular separated from median head scales by its full length; femoral pores rather few, averaging 15.5 in fe-

males, 17.2 in males; lamellae on 4th toe average 29.1; dorsolateral light lines relatively well defined in all specimens, even adult males; upper lateral dark zone broken in adults (both sexes) by vertical light lines which tend to reach the dorsolateral light line and expand somewhat *below* its level at the position of the upper lateral light line (as most other *undulata*); young lined, lacking a dorsolateral dark line. The dorsal spotting is rather variable, but tends to be prominent. The tail is brightly marked below with blue, in adults.

Range. Pacific slopes from the Isthmus of Tehuantepec in Oaxaca, near Niltepec, southeastward to Costa Rica.

Localities. We have examined 377 specimens from the following localities: *Oaxaca*: near Niltepec (EHT-HMS Nos. 27505-27506). *Chiapas*: Tapachula (EHT-HMS Nos. 11917-11924, 15130-15135); Tonalá (HMS Nos. 18728-18787, 18990-19010); La Esperanza (near Acacoyagua) (HMS Nos. 13485-13516, 13591-13615, 13699-13730, 13877, 13937-13994, 14056-14085, 14098-14099, 14141-14155, 14228-14272, 14407-14413, 14425, 15626, 17424-17425); Cruz de Piedra, Las Nubes, Salto de Agua, Finca Juárez, and Colonia Soconusco, all in the vicinity of La Esperanza (HMS Nos. 14506, 14592-14596, 15276, 15940-15941, 16655-16659, 17398). Data have been taken only on the Niltepec intergrades and twenty-five specimens of each sex from Tapachula (all specimens) and the vicinity of La Esperanza. Tabulated data excludes the intergrades. The only other locality known to us is Huehuetán, *Chiapas*, represented by two specimens in the U. S. National Museum.

Discussion. The secondary row of small scales between the supraoculars and superciliaries, a character which has been accepted as the chief peculiarity of *u. parva*, is subject to some variation. In only six specimens (of 49) are there two complete rows (*i. e.*, to the posterolateral border of the first supraocular); in others the secondary row varies in length from complete absence nearly to the extreme condition of full length. For convenience in tabulation we arbitrarily allocated every specimen to one of five conditions: absence of secondary row (0), secondary row extending to a point at one-half the length of the third supraocular ($\frac{1}{2}$), the full length of the third supraocular (1), to a point at one-half the length of the second supraocular ($1\frac{1}{2}$), and the full length of the second supraocular (2). Variation in length of the row of small scales between the supraoculars and median head scales, another character which has been considered of considerable significance in *u. parva*, was similarly tabulated. Results of these tabulations as well as

femoral pore and lamellar counts are given in Table 16. They verify the value of the supraocular characters in defining *u. parva*.

TABLE 16. Variation in *A. u. parva*

CHARACTER		Counts	Range	Average
Femoral pores one side . . .	♂ ♂	49	15-21	17.2*
	♀ ♀	49	13-19	15.5
Lamellae on 4th toe		97	26-33	29.1
Granules between supraoculars and superciliaries†		49	0-2†	1
Granules between supraoculars and median head scales†		50	½-2†	1

* Slevin (1942: 466) records the counts of 572 thighs; his range is 11 to 21, two greater than that recorded here. The average, sexes combined, was 16.2, extremely close to our average, 16.35.

† See text for explanation.

The race is of about the same size as most forms of *undulata*, the largest male measuring 109 mm. snout to vent, the largest female 95 mm. It is markedly smaller than *u. undulata* or *u. hartwegi*, and larger than *u. stuarti*.

Two specimens from "between Niltepec and La Gloria," Oaxaca (EHT-HMS 27505-6), while similar to *u. parva* in most respects, resemble *u. undulata* in others and are accordingly, we think, to be considered intergrades. One (No. 27506) is a juvenile female measuring 52 mm. snout to vent. There are four rows of preanals, the last of which consists of paired scales; there are 15-15 femoral pores; the median mesoptychial is enlarged; and the dorsolateral light spots are large and somewhat wider than the dark inner spaces. There is an incomplete second row of granules between the posterior supraoculars and the superciliaries. Likewise the last supraocular is almost completely separated from the median head scales and two or three small scales are intercalated between the other supraoculars and the median head scales. Except for the character of the preanals this specimen resembles *u. parva*.

The other specimen is an adult male measuring 91 mm. snout to vent. There are five rows of preanals, all the median scales of which are paired; there are 18-18 femoral pores; the median mesoptychials are small; the dorsolateral light spots are large and conspicuous, subequal in width to the spaces between; and the dorsal spotting is greatly reduced, nearly absent. There is a very incomplete secondary row of granules consisting of only 3-4 scales, between the supraoculars and the superciliaries; and the last supraocular is broadly in contact with the frontoparietal. The character of

the preanals, the upper lateral spotting, and the additional granules between supraoculars and superciliaries clearly are typical of *u. parva*; while the absence of dorsal spotting, the small median mesoptychials, and very broad contact of the last supraocular with the median head scales are typical of adult males of *u. undulata*.

Both specimens clearly approach *u. parva* more closely than *u. undulata* although certain characters parallel those of the latter race. In considering them as representatives of an intergrading population we emphasize that they are nearly typical *u. parva*. This locality is the nearest to the range of typical *u. undulata* from which specimens of *u. parva* have been taken.

The exact locality is open to some doubt, yet is of considerable importance since Niltpec is on the Pacific slopes at an elevation of about 200 ft.; while La Gloria is on the Atlantic at about 1,500 ft. They are separated from each other in a straight line by the Sierra Madre, which there reaches an elevation of somewhat more than 4,500 ft. We assume in referring these specimens to *u. parva* that they were taken on the Pacific slopes, for *u. stuarti* is to be expected on the Atlantic slopes. We do not believe that these specimens involve *u. stuarti* or *u. amphigramma* (which at this point are completely isolated by the Sierra Madre from the Pacific coast), since none of the unique characters and few of the general characters are possessed. The brown bands bordering the dorsolateral light stripes medially, which are universally present in *u. stuarti*, are here absent. One specimen has a nearly complete row of median preanals, a condition never occurring in *u. stuarti* or any other Atlantic coast form; and the large upper lateral light spots are never found in *u. stuarti*.

Comparisons. This race is unique in the possession of a secondary row of small scales between the supraoculars and superciliaries and in the considerable extent of the row of small scales forward between the third supraocular and median head scales.

*Ameiva undulata dextra** subsp. nov.

(Fig. 2C)

Holotype. Adult male, EHT-HMS No. 11966, near Rincón, Guerrero, collected by Edward H. Taylor and Hobart M. Smith, 1932.

Paratypes. Thirteen, including three topotypes (EHT-HMS Nos. 11964-5, 11967); one from Organos, Guerrero (EHT-HMS No.

* In reference to the occurrence of this form on the right (southern) watershed of the Río Balsas.

11963); one from El Treinta, Guerrero (EHT-HMS No. 11683); three from Acapulco, Guerrero (EHT-HMS Nos. 11680-2); and five from 8 kilometers east of Coyuca, Guerrero (HMS 5234-8). All those in the EHT-HMS collection were secured by the same collectors and at the same time as the type; those in the U. S. National Museum (HMS) were collected February 7, 1939, by Hobart M. and Rozella Smith.

Diagnosis. Related to *u. undulata* and *u. sinistra*, having essentially a single median row of preanals, and a median row of enlarged gulars. Differs from *u. undulata* in pore counts and in preanal rows: in males femoral pores generally 19 or more on one side (73%), 38 or more on both sides (86%); in females femoral pores usually 17 or more on one side (62.5%), 34 or more on both sides (50%); 5 rows of preanals or less (100%). Differs from *u. undulata* and *u. sinistra* in having the last preanal divided generally (85.8%) and in pattern; lateral markings showing little tendency to be arranged vertically; upper lateral light spots in males tending to form a continuous broad band; and back little mottled.

Description of type. Head scales typical; frontonasal separated from both rostral and frontal, broadly in contact laterally with post-seminasal; four supraoculars, anterior in contact with frontal and narrowly with loreal, posterior very small; one row of small scales between three posterior supraoculars and superciliaries; third supraocular very broadly in contact with frontoparietal, latter very narrowly in contact with second supraocular; only three small scales extending forward from posterior corner of supraorbital disc adjacent to the parietal and interparietal, completely separating the last supraocular from these scales; interparietal single, half as large as parietals; two rows of large flat scales posterior to parietals; three suboculars; one frenocular; one preocular; five supralabials to below middle of eye, two following; five infralabials; one undivided post-mental; five chinshields on either side, separated from posterior three infralabials by two rows of smaller scales; central gulars enlarged, very irregular;† enlarged mesoptychials larger than median gulars, extending laterally nearly to level of arm insertion.

Dorsals subgranular, subconical, slightly mucronate; ventrals in eight longitudinal rows, thirty from gular fold to preanal region; five rows of preanals, each of the anterior four with an enlarged median scale, posterior row consisting of enlarged paired scales;

† This is an anomaly; in others the gulars are enlarged and in a regular median row.

largest preanal slightly smaller than largest mesoptychial; femoral pores 20-21; lamellae under fourth toe 28-29.

Two rows of radials, anterior smaller; two rows of hum. rals, posterior smaller; one row of postbrachials; three rows of tibials, posterior much the smallest, anterior somewhat the largest.

Snout to vent, 84 mm.; tail, 205 mm.; hind leg, 62 mm.; foreleg, 32 mm.; snout to gular fold, 30 mm.; snout to anterior margin of ear, 22 mm.

Ground color dull yellowish-brown; dorsolateral light stripe very faintly evident, broken over most of its length into small spots; a narrow, irregularly serrate-edged, dark brown band bordering this laterally; lateral to this a broader, light blue, upper lateral stripe beginning on shoulder and disappearing at base of tail, with irregular edges, bordered laterally by a dark brown area similar to that which borders it medially; lateral ground color merging with the lateral dark border of the upper lateral light stripe; numerous small, light bluish spots on sides, tending more or less to be arranged in vertical series; middorsum uniform; no distinct markings on head; limbs with irregular, very feeble light spots above. Venter discolored.

TABLE 17. Variation in *A. u. dextra*

CHARACTER		Counts	Range	Average
Femoral pores, one side	♂	15	15-21	19.1
	♀	9	15-19	16.6
Femoral pores, total	♂	7	31-42*	38.6
	♀	4	30-35	32.5
Lamellae on 4th toe	♂	14	27-31	29.1
	♀	6	28-31	28.3
Row of pre-nals		13	4-5	4.4

* One aberrant specimen of the 7 available has a total count of 31 (15-16); all others have 38 or more.

Variation. Four adult males including the type are available; in two of these the upper lateral light stripes are continuous, while in the other two they are broken into large, more or less rectangular, or irregular spots separated from each other by short vertical dark brown streaks of varying width. The other four males, varying in snout-vent length from 48 to 60 mm., are similar to the adults except that the lateral pattern is not so clearly evident; the youngest is so discolored that no pattern can be discerned. One shows a developing continuous upper lateral light stripe similar to that of the type; in the other two that stripe is broken and there is a tendency

in one to form fairly distinct vertical bars on the sides. Thus in that of the seven males in which this character is evident the upper lateral light stripe is continuous. The dorsolateral light stripes are very poorly defined, even in the smaller specimen.

Females possess a pattern essentially the same as that of the males, with the following differences. The dorsolateral light stripes are well defined throughout life, although more distinct in the shoulder region; their median borders are ill-defined, the lateral border sharply delimited. There is a distinct upper lateral dark zone between the dorsolateral and lateral light lines. In two specimens vertical bars are dimly evident in this zone, while in the others no markings are evident. The lateral light line is broken into a series of small, rounded or elongate light spots. The sides below this may either be uniform brownish or provided with small light blue spots arranged irregularly or tending to form vertical series.

The largest male measures 113 mm. snout to vent, the largest female 80 mm.

The median scales in the posterior row of preanals are paired in twelve specimens (excluding the type), single in two. In two specimens the median gulars are irregular, in one all except two are subdivided, while in all others there is a single regular median row. Variation in femoral pore, preanal and lamellar counts is indicated in Table 17.

TABLE 18. Comparisons of *A. u. dextra* and *A. u. undulata*

CHARACTERS			<i>dextra</i>	<i>undulata</i>
Femoral pores	♂ ♂	one side only	19 or more 73%	18 or less 81%
		total	38 or more 86%	37 or less 90%
	♀ ♀	one side only	17 or more 62.5%	16 or less 76.7%
		total	34 or more 50%	33 or less 84.5%
Preanals		number of rows	5 or less 100%	6 or more 65%
		5th (or last if less than 5)	divided 85.8%	entire 89.2%
Pattern		lateral vertical bands	poorly developed, particularly in females	well developed, young and adult males and females
		middorsal markings	greatly reduced or absent	well developed
		continuous upper lateral light band in males	present in 43% (3 out of 7 specimens), represented by large, narrowly separated light blotches in the remainder (57%)	never present or represented by light spots as large as intervening dark spaces 100%

Comparisons. The present race is easily distinguishable from all the Atlantic coast forms of *Ameiva undulata*, as well as *u. parva*, by the essentially single row of preanals (in spite of the subdivision of the posterior scale), which character links it with *u. undulata* and *u. sinistra*. Comparisons with the former are given in Table 18, and with the latter in Table 20.

Discussion. Four unique characters, within the group with a median row of preanals, define *u. dextra*: the divided posterior preanal, the absence of middorsal markings, the reduction of the lateral bars, and the presence of a continuous upper lateral light stripe. In all these respects *u. undulata* and *u. sinistra* are alike. The last possibly is not of sufficiently frequent occurrence to be a reliable indicator in itself, since less than fifty percent of known *u. dextra* males possess the stripe; yet in conjunction with the other characters it is of considerable importance since it is unknown in either of the adjacent races, and in fact is known elsewhere in *Ameiva undulata* only in *u. amphigramma*. In the latter race the stripe is of regular occurrence. Whether the partial parallelism of these two races in this character is coincidental or indicative of close relationship is not certain; we believe the former. In *u. undulata* the broad upper lateral band is usually not evident at all, even as isolated spots, while in *u. sinistra* large light spots are present in its position. Longitudinal extension of the spots would result in creation of a line typical of *u. dextra*. In the latter all adult males which lack the continuous line do at least have the large spots in its position.

It is unfortunate that so few *u. dextra* have been available. We believe that a larger series will reveal a more appreciable difference from *u. undulata*, particularly of females in femoral pore counts, than is apparent now (*cf.* Table 18). The number of rows of preanals is markedly different in the two races, but the extent of overlap is considerable; further data on *u. dextra* are required.

The nature of the dorsal and lateral markings is evaluated with some difficulty since there is no sharp distinction, and, moreover, an actual overlap of extremes in the two races. Vertical bars are, nevertheless, a conspicuous feature of *u. undulata*, even in the young, which usually (*i. e.*, in most races of *undulata*) have no transverse markings. The usual condition obtains in *u. dextra*, few specimens showing marked transverse bars. The distinction between the two races in this character is most clearly evident in females; there is little postnatal ontogenetic change in specimens of this sex in *u. dextra*.

The dorsal spotting is not extensive in any specimen of *u. dextra*, although it is prominent in most *u. undulata*, with the exception of adult males.

Range. Southern slopes of the Sierra Madre del Sur of Guerrero and perhaps extreme western Oaxaca, below about 4,000 ft. above sea level. In addition to the types records are available of specimens from Juquila, *Oaxaca*, Chilpancingo (USNM), Cocoyul (Gadow), and Los Cajones (Gadow), *Guerrero*.

*Ameiva undulata sinistra** subsp. nov.

Holotype. Adult male, EHT-HMS No. 11908, from Manzanillo, Colima, collected by Hobart M. Smith, 1935.

Paratypes. Sixty, including 8 from Quesería, Colima (EHT-HMS Nos. 11906-7, 11946-8, 14499, 15121; UMMZ No. 80109); 20 from Hacienda Paso del Río, Colima (EHT-HMS Nos. 11909-16, 11949-51, 14500, 15122-9; UMMZ Nos. 80110, 80111 [3], 80112 [5], 80115 [3], 80120); Salvador (UMMZ No. 80116); Pascuales (UMMZ Nos. 80113 [3], 80114); and Periquillo (UMMZ Nos. 80117 [11], 80118 [2], 80119).

Diagnosis. Related to *u. dextra* and *u. undulata*, having a single row of median preanals (posterior sometimes divided, 37.7%), and a single median row of enlarged gulars. Differs from *u. dextra* in usually having all the median preanals entire (or at least the fifth is entire if there are more than five preanals), and in pattern: lateral vertical bars present in males, taking the form of a tigroid pattern (dark bars relatively widely separated); well developed middorsal markings; and no continuous upper lateral light band in males (although there is a tendency to form large light spots). Differs from *u. undulata* in pore counts, preanals and in pattern: in males femoral pores generally 19 or more on one side (54.4%), thirty-seven or more on both sides (63%); in females femoral pores usually seventeen or more on one side (81.2%), thirty-four or more on both sides (72.8%); five rows of preanals or less (95%); and in the presence of large upper lateral light spots in adult males.

Description of type. Similar to the type of *u. dextra* except as follows: Three supraoculars; interparietal asymmetrically split longitudinally; central gular scales normal with a median row of enlarged scales; largest mesoptychial subequal in size to median gulars; thirty-two ventrals from gular fold to preanal region; four

* In reference to the occurrence of this form on the left (northern) watershed of the Río Balsas.

rows of preanals, each of the anterior two rows consisting of a pair of scales, third row with one very large scale, larger than any mesoptychial or gular, fourth row with three scales, the central one twice as large as the others and approximately three-fifths the size of the preceding scale; femoral pores 18-19; lamellae under fourth toe 30-30.

Snout to vent, 90 mm.; tail 228 mm.; hind leg, 71 mm.; foreleg, 34 mm.; snout to gular fold, 33 mm.; snout to anterior margin of ear, 23.5 mm.

Middorsum bluish gray-brown, varied by small dark brown spots, largest posteriorly, beginning on rump and becoming gradually smaller anteriorly and disappearing at the level of the shoulders; these spots tend to form two rows; dorsolateral light stripe very dimly evident, bordered laterally by a continuous narrow dark brown band which varies in intensity in pigmentation; lateral to this is a longitudinal series of large, subquadrangular, bluish-white spots, each connected ventrally with one or more wavy, vertical, light blue lines which extend to the sides of the belly; the upper lateral light spots are separated from each other by dark bars one-half or one-third as wide as the light spots; these dark bars expand in width on the sides of the body.

Variation. Males show little variation in pattern. The smallest available (72 mm. snout to vent) possesses the typical adult pattern. The most conspicuous variation is in the size of the upper lateral light spots; in four specimens they are not or scarcely wider than the intervening dark spots, while in all the other twenty-four specimens the light spots are enlarged much as in the type.

TABLE 19 Variation in *A. n. sinensis*

CHARACTERS		Counts	Range	Average
Femoral pores, one side	♂ ♂	57	17-22	18.8
	♀ ♀	61	15-22*	17.5
Femoral pores, total	♂ ♂	27	31-43	37.7
	♀ ♀	33	31-42	35.1
Lamellae on 4th toe	♂ ♂	57	27-32	29.7
	♀ ♀	54	26-32	29.1
Rows of preanals		61	3-6	4.6

* Only one aberrant specimen has 22 pores on one side. All other specimens have 20 or less.

In females the dorsal mottling is somewhat better developed than in males; the dorsolateral light lines are somewhat more distinct; the upper lateral light spots are not or poorly developed; and the

lateral light line, which is not or scarcely evident in males, is strongly indicated by a series of elongate spots; below this irregular, narrow, wavy, vertical light streaks may or may not be present.

The largest male measures 109 mm. snout to vent, the largest female 95 mm.

Variation in femoral pores, preanal and lamellar counts is given in Table 19. The central gulars are irregular in three specimens, but in all others they are arranged in a single, regular median row in which no more than one scale is divided, if any.

Comparisons. Like *u. undulata* and *u. dextra* the present race is distinguishable from all other forms of *Ameiva undulata* by the presence of a single median row of preanals. Comparisons with *u. undulata* and *u. dextra* are presented in the accompanying tables (Tables 20 and 21). The pattern characters which distinguish *u. sinistra* from *u. dextra* and *u. undulata* are perhaps the most important; in comparison with the former, the tigroid pattern of males is very distinctive, and equally striking in comparison with *u. undulata* are the large upper lateral light spots. Obviously the three races are very close, but since there are some very significant differences (which by themselves would not meet the minimum require-

TABLE 20. Comparisons of *A. u. sinistra* with *A. u. dextra*

CHARACTERS		<i>sinistra</i>	<i>dextra</i>
Preanals	5th (or last if less than 5)	entire 62.3%	divided 85.8%
Pattern	lateral vertical bands	well developed in adult males	poorly developed, particularly in ♀♀
	middorsal markings	well developed	greatly reduced or absent
	continuous upper lateral light band in ♂♂	never present	present in 43% (3 out of 7 specimens)

ment of seventy percent recognition) in scutellation, in addition to those in pattern, we feel that the sum total of peculiarities characterize a population recognizably as well as genetically distinct. *A. u. sinistra* is physiographically isolated from other forms of *undulata*, being separated by the arid Balsas Basin from *u. dextra* and *u. undulata*, and by the plateau from other forms of the Atlantic coast. The isolation makes reasonable the divergence of *u. sinistra* and *u. dextra*, which probably would not remain even as feebly distinct as they are at present if no barrier existed between them.

Range. Pacific coastal drainage from the arid Balsas Basin at

TABLE 21. Comparisons of *A. u. sinistra* with *A. u. undulata*

CHARACTER		<i>sinistra</i>	<i>undulata</i>
Femoral pores... ♂♂	one side only	19 or more 54.4%	18 or less 51%
	total	37 or more 63.0%	36 or less 75%
♀♀	one side only	17 or more 81.2%	16 or less 76.2%
	total	34 or more 72.8%	33 or less 84.5%
Prenals.....	number of rows	5 or less 95.0%	6 or more 65%
Pattern.....	upper lateral light spots in adult males	large, wider than intervening spaces 83.3%	small, narrower than intervening spaces in all males 100%

the border of Guerrero and Michoacán northwestward at least to Jalisco, and perhaps farther; the northern drainage of the Río Balsas, at lower elevations and in humid localities, from Michoacán to Puebla. It is completely isolated from *u. dextra*, its closest relative both geographically and taxonomically, by the extremely arid valley of Río Balsas. Aside from the 61 in the type series, specimens have been recorded from Tenacatita and Tenacatita Bay, *Jalisco*; Colima, *Colima*; Uruapan, *Michoacán*; and Chiautla, *Puebla*. The U. S. National Museum has specimens (not examined) from Ixtapa, *Jalisco*, and Puente de Ixtla, *Morelos*. All of the specimens from the southern part of the range of *u. sinistra* are of special interest; their allocation with this race is tentative.

Ameiva undulata undulata (Wiegmann)

(Fig. 2B)

Cnemidophorus undulatus Wiegmann, 1834: 27 (type locality, México by inference restricted to Tehuantepec by Smith 1940: 56).

Diagnosis. A member of the *undulata* group of *Ameiva*, with usually one row of preanals (89%), a median row of abruptly enlarged gulars, one row of granules between supraoculars and superciliaries, third supraocular generally at least partly in contact with median head scales. Most closely similar to *u. dextra* and *u. sinistra*, differing from them in the following: reduced number of femoral pores, greater number of rows of preanals, lack of division of the last preanal (from *u. dextra* only), presence of tigroid lateral marks, presence of well-developed middorsal markings (from *u. dextra* only), and reduction of the size of the upper lateral light spots.

Range. The Pacific slopes of the Isthmus of Tehuantepec in Oaxaca, as far west as Puerto Angel and eastward about to Niltepec.

Localities. A series of thirty-seven specimens has been examined from the following localities, all in Oaxacá: El Limón (USNM No. 18383); Palmar (USNM Nos. 18543-6, 185438); Tres Cruces (USNM Nos. 12052-7, 12392-5, 12499-12508, 16278-87, 18541-2). In addition, two intergrades with *u. dextra* are available as follows: one (EHT-HMS No. 27516) is from San Felipe Lachillo, Oaxaca; and the other (EHT-HMS No. 27523) is from Finca Mirador, between San Felipe Lachillo and San Juan Guivini, Oaxaca. Records for localities other than those cited above are as follows: Cafetal Concordia (USNM), Juchitán (USNM), Puerto Angel (USNM), Totontepec (USNM), Tehuantepec (USNM), and Ranchería La Manga (UMMZ), all in Oaxaca. Of particular importance are those from Cafetal Concordia and Puerto Angel, which probably are intergrades with *u. dextra*, as indicated by the existence of intergrades nearby at San Felipe Lachillo; they may well approach *u. dextra* more closely than *u. undulata*, however, and be referable to the former race.

Coloration. The salient features of the pattern in males are as follows: young with numerous middorsal dark spots decreasing in size and number anteriorly; in adults these spots disappear completely or nearly so; dorsolateral light stripes not evident except feebly in juveniles; upper lateral dark stripe broken by narrow vertical light streaks narrower than, or not more than subequal to the dark spaces between; even in the youngest specimens the dark band is as described for the adults; sides with irregular light markings or with narrow vertical light lines which frequently are fused with the light streaks in the upper lateral zone, forming a rather bold, barred pattern of alternating broad dark bands and narrow light streaks. Throats suffused with orange.

There appears to be less sexual dimorphism in this race than in any other in México in dorsal pattern. The middorsal spotting is more prominent in the females and does not disappear in the adults.

TABLE 22. Variation in *A. u. undulata*

CHARACTERS	Counts	Range	Average
Femoral pores, one side..... ♂ ♂ ♀ ♀	42 26	14-20 13-18	17.4 15.5
Femoral pores, total..... ♂ ♂ ♀ ♀	20 13	29-29 27-35	35. 31.
Rows of preanals.....	37	4-7	5.8

The sides, however, are marked much as in the males, although perhaps more dimly. In females the throat is not marked with orange.

Scutellation. There is a strong tendency for the gulars to be arranged in a single median row. The median preanals are arranged in a single row, with the exception of the posterior scale which is frequently divided (52%). Hartweg and Oliver (1937:7) record that there is a single row of median, enlarged, preanal scales . . . in . . . 91.5 percent of their specimens (47). The discrepancy between their percentage and ours can be attributed to the difficulty of determining which is the last row of preanals. Preceding the anus is one row of small scales varying greatly in size, sometimes nearly equalling the other preanals. They vary more in disposition than the others, as indicated by our counts. To eliminate the variation caused by consideration of the small posterior row we have arbitrarily selected the 5th row from the abdominals as the critical one, disregarding the form of the following rows. Thus the fifth (or the last if less than five) median preanal is entire in 33 out of our 37 specimens (89.2%).

Our largest male slightly exceeds Hartweg and Oliver's (1937:7) figure, measuring 116 mm. snout to vent. Their maximum measurement for females (95 mm.) remains the record.

Variation in the number of femoral pores and preanal rows is presented in Table 22.

Intergradation. The specimens from near San Felipe Lachillo combine certain characters of *u. undulata* and *u. dextra*. They resemble *u. dextra* in number of femoral pores (20-21 male, 16-18 female). The female (No. EHT-HMS 27523) has only four rows of preanals, and in the male the posterior two preanals are paired. However, they resemble *u. undulata* since in the female the preanals are undivided, and in the male there are six rows. The pattern also resembles that of *u. undulata*; the sides in both are strongly barred with wide, dark bands, and the middorsal area is strongly spotted. We regard these specimens as approaching *u. undulata* more closely than *u. dextra*.

Ameiva festiva edwardsii Bocourt

Ameiva edwardsii Bocourt, 1873: 1-2 (type locality Izabal and Santa-Maria de Panzos near Rio Polochic, Guatemala; cotypes in Mus. Hist. Nat. Paris).

Diagnosis. Most closely related to *f. festiva* but differing from that race in having the most posterior sublabial scale divided into three scales which form a rough triangle. Differs from *A. undulata* in having the outer row of ventrals considerable smaller than the

others; in possessing fewer enlarged median gulars; in having one extremely enlarged median preanal; and in possessing two rows of distal tibials.

Range. Atlantic foothills from southern México (Tabasco) through Honduras, in heavy forests.

Locality records. We have examined 49 specimens from the following localities: Piedras Negras, Petén, Guatemala; Palenque, Chiapas, and from Chiapas just across the border from Piedras Negras. The only other locality record for this race in México is Ixtacomitán, Chiapas (Dugès, 1894).

Discussion. The original diagnostic characters proposed by Bo-court (1873) were proven by Stuart (1943) to be fallible. However, Stuart was able to diagnose the race on the character of the posterior sublabial.

Of the 42 USNM specimens we have examined, in only one is the posterior sublabial entire (one side). In five specimens it is divided into four scales, and in another five it is divided into two. Variation in femoral pores and lamellae under the fourth toe is given in Table 23.

TABLE 23. Variation in *A. festiva edwardsii*

CHARACTER	Counts	Range	Average
Lamellae under 4th toe	69	23-33	29.4
Femoral pores	♀ 40 ♂ 34	19-23 19-22	20.25 20.6

The species differs so remarkably from *undulata* that the relationship cannot be close. There are several rows of small scales between the posterior part of the frontoparietals and the supraoculars; the gulars are extremely large; there is but one row of enlarged mesoptychials; the distal preantibrachials are in one row; there is but one row of prebrachials; there are but two rows of large tibials; the femorals are large and fewer; the preanals extremely large and not grading into the much smaller adjacent scales; the ventrals in the lateral row are small; the postantibrachials are smaller; and there are various other peculiarities, less easily described.

There is surprisingly little dimorphism in dorsal and lateral pattern. In both sexes the juveniles are dark brown with a conspicuous, broad, light blue middorsal stripe extending from the rostral to the rump, where it fades. The edges of the stripe from the shoulder

region posteriorly are wavy. A fine dorsolateral light stripe extends from the head in line with the superciliaries to the tail; it is discontinuous usually, broken into numerous short lines. A discontinuous lateral light line extends from the upper postocular region above the tympanum to the upper edge of the groin. In the shoulder and axillary regions a number of vertical light blue bars extend from the level of the forelimb to the lateral light stripe.

This pattern remains constant throughout life except for the middorsal light band, which gradually becomes fainter until it disappears in specimens measuring about 95 mm. snout to vent. The dark color originally occupying all the area between the dorsolateral light lines and the middorsal stripe decreases in extent and forms a row of dark spots on either side, each spot marking the approximate position of an indentation into the middorsal stripe. The spots remain as long as the middorsal stripe is evident, but finally disappear. The ground color between the dorsolateral light stripes is then light brown. The color remains dark between the dorsolateral and lateral light lines, but the sides below the latter become lighter, like the middorsum.

Males are bluish below and no doubt in life are strikingly different from females in the entire ventral color, but the preserved material examined is so discolored that no accurate description of differences in ventral color can be given.

Males appear to have wider heads and more slender bodies than females.

SUMMARY

1. Ten forms of *Ameiva undulata*, six of which are new, and one form of *Ameiva festiva* occur in Mexico:

- a. *Ameiva undulata hartwegi* Smith
- b. *Ameiva undulata gaigeae* subsp. nov.
- c. *Ameiva undulata podarga* subsp. nov.
- d. *Ameiva undulata amphigramma* Smith and Laufé
- e. *Ameiva undulata stuarti* Smith
- f. *Ameiva undulata thomasi* subsp. nov.
- g. *Ameiva undulata parva* Barbour and Noble
- h. *Ameiva undulata dextra* subsp. nov.
- i. *Ameiva undulata sinistra* subsp. nov.
- j. *Ameiva undulata undulata* (Wiegmann)
- k. *Ameiva festiva edwardsii* Bocourt

2. Characters of primary importance in differentiating subspecies in *Ameiva undulata* are: (1) size and arrangement of the median gular scales, (2) arrangement of the preanals, and (3) separation of the third supraocular from the median head scales and, by two rows of granules, from the superciliary scales.

3. Characters of secondary importance are: (1) pattern, (2) number of lamellae under the 4th toes, (3) number of femoral pores, (4) the arrangement of the gulars, (5) the size of the lateral gulars, and (6) the arrangement of the preanals.

4. A tentative phylogeny of the four subspecific sections of *Ameiva undulata* is suggested.

5. The Matthew concept of peripheral dispersal of primitive forms is upheld insofar as it may be applied to a comparison of the end products of several lines of derivatives from common ancestors, but it is not applicable to evolution in single lines of derivatives, in which peripheral specialization is the rule.

6. Differentiation of all races of *Ameiva undulata* appears to have been accompanied by isolation, either *in situ* or by migration. The rate of differentiation appears to be the same in either case and is correlated chiefly with time.

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PLATE I

- A. *A. u. thomasi*, EHT-HMS No. 13330. La Libertad. Chianas.
- B. *A. u. stuarti*, HMS No. 8798, Tenosique, Tabasco.
- C. *A. u. amphigramma*, male, EHT-HMS No. 11983, Tierra Colorada, Veracruz.
- D. *A. u. amphigramma*, female, EHT-HMS No. 11971, Tierra Colorada, Veracruz.

PLATE I

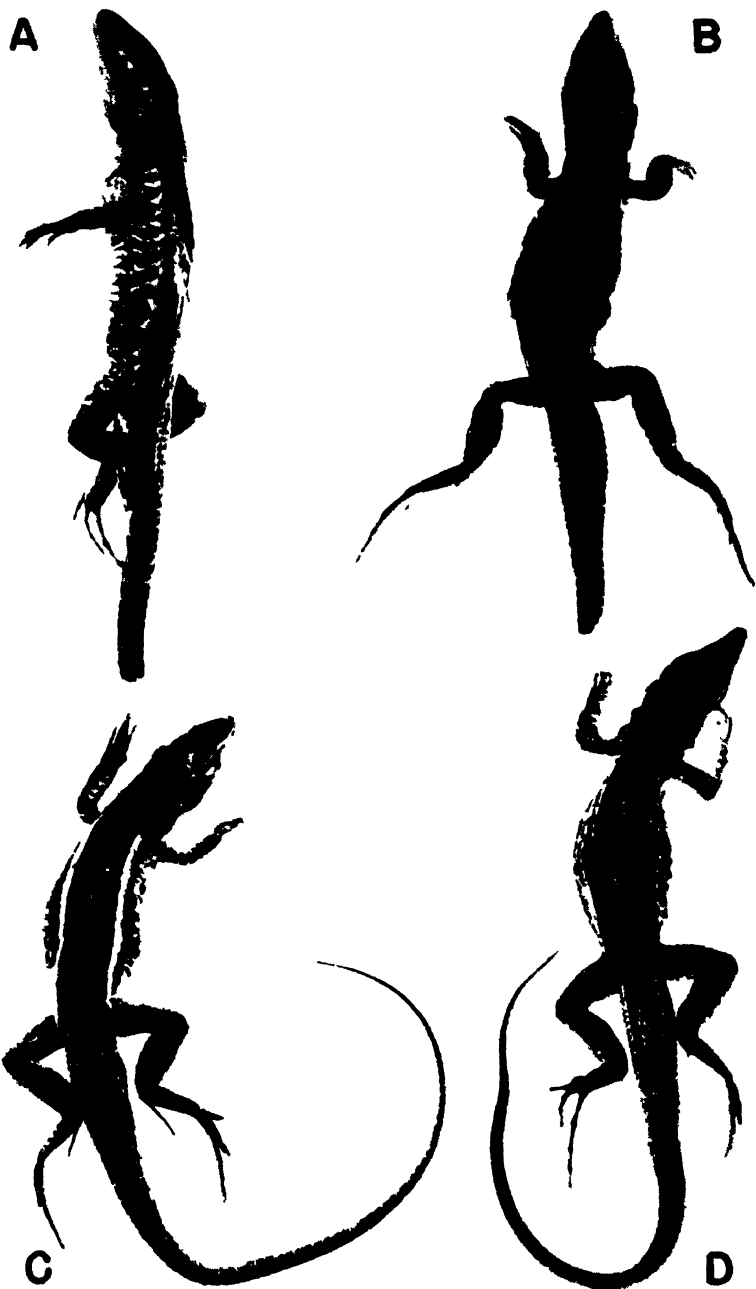
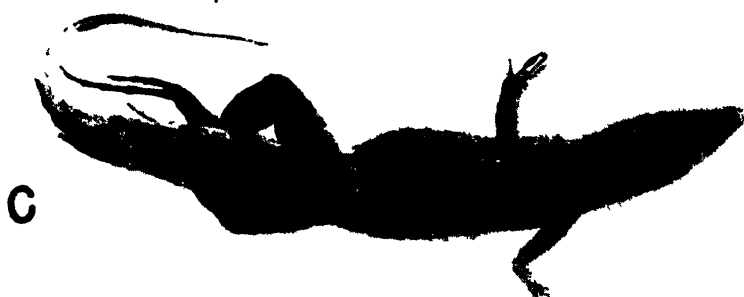
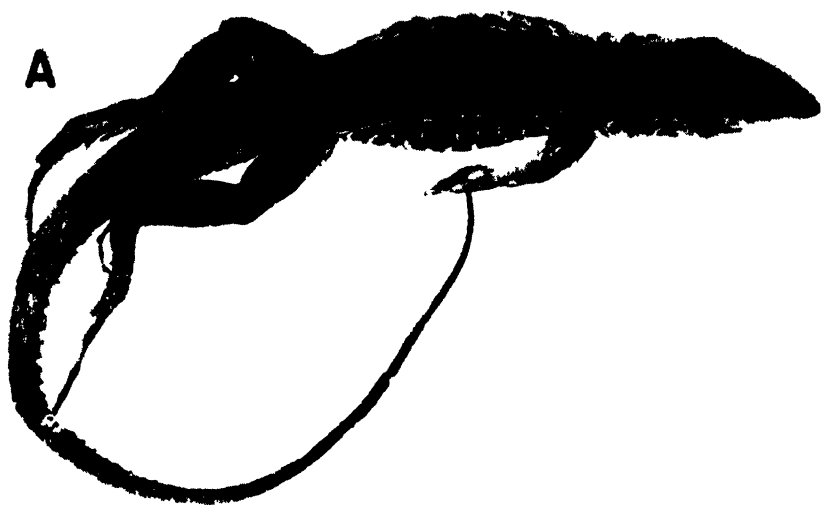


PLATE II

- A. *A. u. parva*, EHT-HMS No. 11921, Tapachula, Chiapas.
- B. *A. u. hartwegi*, HMS No. 7801, Piedras Negras, Guatemala.
- C. *A. u. gaigeae*, EHT-HMS No. 11927, Progreso, Yucatán.

PLATE II



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[No. 3

Preliminary Notes and Speculations on the *Triseriatus* Group of Rattlesnakes in México

HOBART M. SMITH

ABSTRACT: A new subspecies of rattlesnake, *Crotalus gloydii lautus*, is described from the states of Veracruz and Puebla, México; the type is in the U. S. National Museum, collected near El Limón Totalco, Veracruz. Brief diagnoses are given for the five subgroups of the *triseriatus* group of *Crotalus*, based upon scutellation and partly upon cranial characters. One theory of the phylogeny of the members of that group is discussed, and a possible means of reconciling the apparently opposing ideas of peripheral specialization and central specialization is suggested.

RECENT collections from México of the small rattlesnakes comprising the *triseriatus* group have revealed the existence of a previously undefined species subgroup and have made possible a clarification of the relationships of the known forms of the entire group. All the forms of the subgroup of which I am aware have been described, save for one, whose description follows.

The material which furnishes the basis for these notes has been secured partly through the efforts of the members of the Department of Fish and Game at the Agricultural and Mechanical College of Texas; and partly by Dr. E. H. Taylor and myself. I am much indebted to Dr. W. B. Davis and Mr. Max M. Whisenhunt of Texas A. and M. College, and to Doctor Taylor, for permission to study their specimens. To Doctor Taylor I owe a double debt of gratitude for his generous counsel and innumerable other courtesies.

I

Crotalus gloydii lautus subsp. nov.

Holotype. U. S. Nat. Mus. No. 110598, collected by Dyfrig McH. Forbes at the lava beds about one kilometer east of El Limón Totalco, Veracruz, on March 1, 1940. **Paratypes.** E. H. Taylor-H. M. Smith No. 5475, same locality, collected by E. H. Taylor and

H. M. Smith, August, 1932. Texas Coöperative Wildlife Collection No. 822, Lago Salado, about five kilometers west of El Limón Totalco, in the state of Puebla, 8,300 ft., July 25, 1942, collected by S. H. Wheeler.

Diagnosis. A member of the *triseriatus* group with no subloreal; postseminasal* in contact with first and second supralabials, loreal generally (?) in contact with supralabials. Pattern of spots to 44 small, oval spots in a middorsal series; belly nearly immaculate. Differs from *transversus* in having oval blotches instead of narrow crossbands and generally (?) in having the loreal in contact with the supralabials and the lower preocular divided. Differs from *gloydi* in having a larger postseminasal in contact with two instead of just one supralabial, and generally (?) in having the lower preocular in contact with the loreal.

Description of holotype. Adult male. Rostral moderate, portion visible from above about half as long as broad; two large internasals, narrower laterally than medially, length about two-thirds width; a pair of large, oval canthals, somewhat longer than broad, separated from each other medially by a single, elongate scale nearly as large as an internasal; supraocular flat, twice as large as a canthal, slightly longer than distance from end of snout; four scales in a transverse row between supraoculars behind canthals, two (somewhat larger) in the next row, and three in a third row; scales on head posterior to supraoculars nearly uniform in size.

Naris pierced at about the middle at the lower border of nasal; latter completely divided, upper portion of anterior section projecting far posterior to the level of the lower portion; postseminasal less than half size of preseminasal, broadly in contact with first supralabial, narrowly with second, and narrowly with internasal; loreal large, rounded, in contact with second supralabial, canthal, postseminasal, upper and lower preocular, and the anterior pit scale; upper preocular single, lower divided into anterior and posterior halves; scale bordering lower edge of pit wedged between preocular and lacrimal, narrowly separated from orbit; a single row of two scales between orbit and supralabials; two postoculars (on one side the lower postocular and posterior subocular are fused); length of orbit, 3 mm., half its distance from tip of snout. (Fig. 1.)

Supralabials 9-9, posterior border of orbit above the middle of the fifth; infralabials 9-9, the first of each side in contact medially; one pair of small chinshields.

* The terms subloreal, preseminasal and postseminasal are defined on p. 82; see, also, figs. 1-4.

Dorsal scales moderately strongly keeled, except those in the outer two rows; scale rows 21-21-15; ventrals 161; caudals 25, the posterior 3 paired. Total length, 480 mm.; tail length, 40 mm.; basal rattle, 5.5x3 mm.

Dorsal surface pale brown, with 40 dark brown, black-edged median blotches on body, 7 on tail. The blotches are separated from each other by about $1\frac{1}{2}$ scale lengths; they are nearly twice as broad as long, and cover about $2\frac{1}{2}$ scale lengths longitudinally and about 6 or 7 transversely. A dorsolateral row of very indistinct, rounded spots alternates with the middorsal series, occupying the sixth and seventh scale rows. A lateral row of somewhat more distinct spots, alternating with those of the dorsolateral row (coinciding with those of the median row) occupies the 3d, 4th, and 5th rows. A sublateral row of dim spots, alternating with the preceding, occupies the 1st and 2d rows.

The only distinct headmarking is a dark postocular stripe disappearing a short distance back of the angle of the mouth and involving the upper portion of the supralabials; the edges of the band are well defined and straight, bordered with white below and with gray above. The top of the head is generally gray brown between the postocular stripes, varied only by a pair of dim darker spots in the anterior parietal region just back of the supraoculars. The snout, including the anterior supralabials, is dark gray, but the color fades below the eye so that the posterior supralabials are white except for the upper edges. The entire ventral surface of the head is very dark, and darkest on the chin.

Belly nearly white, with scattered dark stippling concentrated laterally. Subcaudal surface moderately darkly stippled.

Variation. In No. 5475, several of the small dorsal head scales are fused between and in front of the level of the orbits (Fig. 2). The lower preocular is divided as in the type, and the loreal bears much the same relation to other scales, except that it is in contact with the upper posterior border of the preseminal, separating the postseminal from contact with dorsal scales. The suboculars are in a single row as in the type, and the labials are the same. It is a young male, measuring 218 mm. snout to vent, the tail, 18 mm.; ventrals, 161; caudals, 24. Blotches as in type, 44 on body, 6 on tail.

No. 822 seems somewhat aberrant in certain respects. Two juxtaposed scales intervene medially between the canthals. The lower preocular is single, tapering anteriorly, and on one side is narrowly in contact with the loreal *inside* the pit (Fig. 3): on the other side the scales are narrowly separated (Fig. 4).

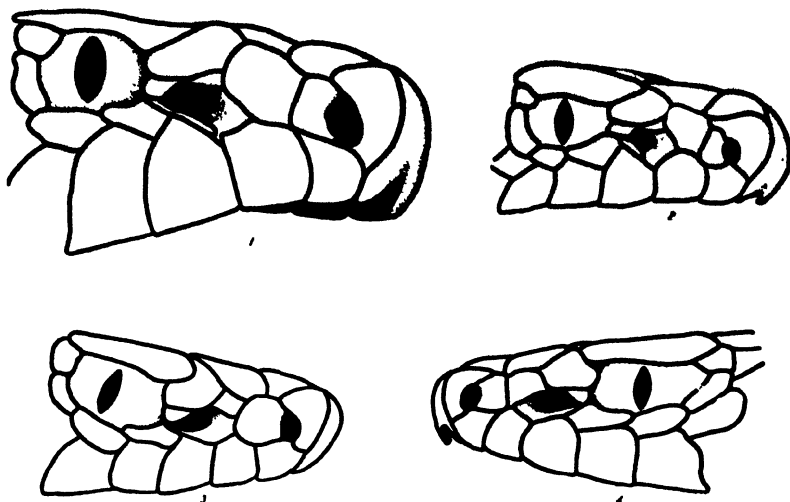


FIG. 1. Lateral view of orbitonasal region of head of *C. g. lautus*. From USNM 110598, type.

FIG. 2. As in Fig. 1, from EHT-HMS 5475, paratype.

FIG. 3. As in Fig. 1, from TCWC 822, paratype, right side.

FIG. 4. As in Fig. 3, left side.

The loreal is greatly reduced on one side, where the postseminasal is greatly enlarged; on that side the pit scale contacts the nasal below the loreal, and the postseminasal contacts the cantal and internasal and is nearly as large as the preseminasal. On the other side the loreal is only slightly reduced, narrowly contacting the labials, but the postseminasal remains in contact with both cantal and internasal. The suboculars and labials are as in the type except 8 infralabials occur on one side. The specimen is a young female measuring 255 mm. snout to vent, the tail, 20 mm.; ventrals, 153; caudals, 20.

II

SUBGROUP COMPARISONS

Gloyd's recent monograph on *Crotalus* (Special Publ. Chicago Acad. Sci., No. 4, 1940, pp. i-viii, 1-270, pls. 1-31, maps 1-22, figs. 1-10) recognizes 7 forms in the 2 species of the *triseriatus* group, 5 belonging to *triseriatus*, and 2 to *lepidus*. The forms now known are as follows:

OMILTEMANUS SUBGROUP:

Crotalus omiltemanus Günther.

Crotalus gloydi gloydi Taylor.

Crotalus gloydi lautus subsp. nov.

Crotalus transversus Taylor.

PRICEI SUBGROUP:

Crotalus pricei miquihuanus Gloyd.*Crotalus pricei pricei* Van Denburgh.

TRISERIATUS SUBGROUP:

Crotalus triseriatus anahuacus Gloyd.*Crotalus triseriatus triseriatus* (Wagler).

LEPIDUS SUBGROUP:

Crotalus lepidus klauberi Gloyd.*Crotalus lepidus lepidus* Kennicott.

SEMICORNUTUS SUBGROUP:

Crotalus semicornutus Taylor.

OMILTEMANUS SUBGROUP

The new subgroup mentioned previously is that here referred to as the *omiltemanus* subgroup. Its segregation as a group of forms distinct from the rest of the *triseriatus* group is of considerable importance. Heretofore its members (except for *transversus*) have been treated as subspecies of *triseriatus*. Certainly that disposition is incorrect, but the arrangement of the forms within the subgroup—as races of a single species or involving several species—is not yet clear.

Primary characteristics. The forms are distinguished from *triseriatus*, whose geographic range they overlap, by a number of striking features. Of greatest importance are the relationships to each other of the scales on the sides of the head; until recently the importance of certain of these scales has not been fully appreciated. In all members* of this section the subloreal s are completely lacking (Figs. 1-4, 18); they are present (1 to 3) in all other species of the genus (Figs. 15-17). The scales referred to as subloreal s are small ones interposed between the loreal and labials, and between the nasal and the pit scales. Since the term loreal has been restricted by Klauber (Trans. San Diego Soc. Nat. Hist., vol. 8, 1936, p. 222) to apply in rattlesnakes to "the scales [one or more] on the side of the head between the postnasal and the preocular . . .," and is generally used in this sense by other specialists, the scales described above cannot be considered as lower loreals; upper and lower loreals do occur in rattlesnakes, but both are between the "postnasal" and the preocular. Thus in the absence of any other term in general use I suggest "subloreal" as one sufficiently appropriate.

* In the type of *transversus*, according to the drawing (Taylor, Univ. Kan. Sci. Bull., vol. 30, 1944, fig. 10, p. 48), there appears to be a subloreal on one side. The scale is, however, a pit scale.

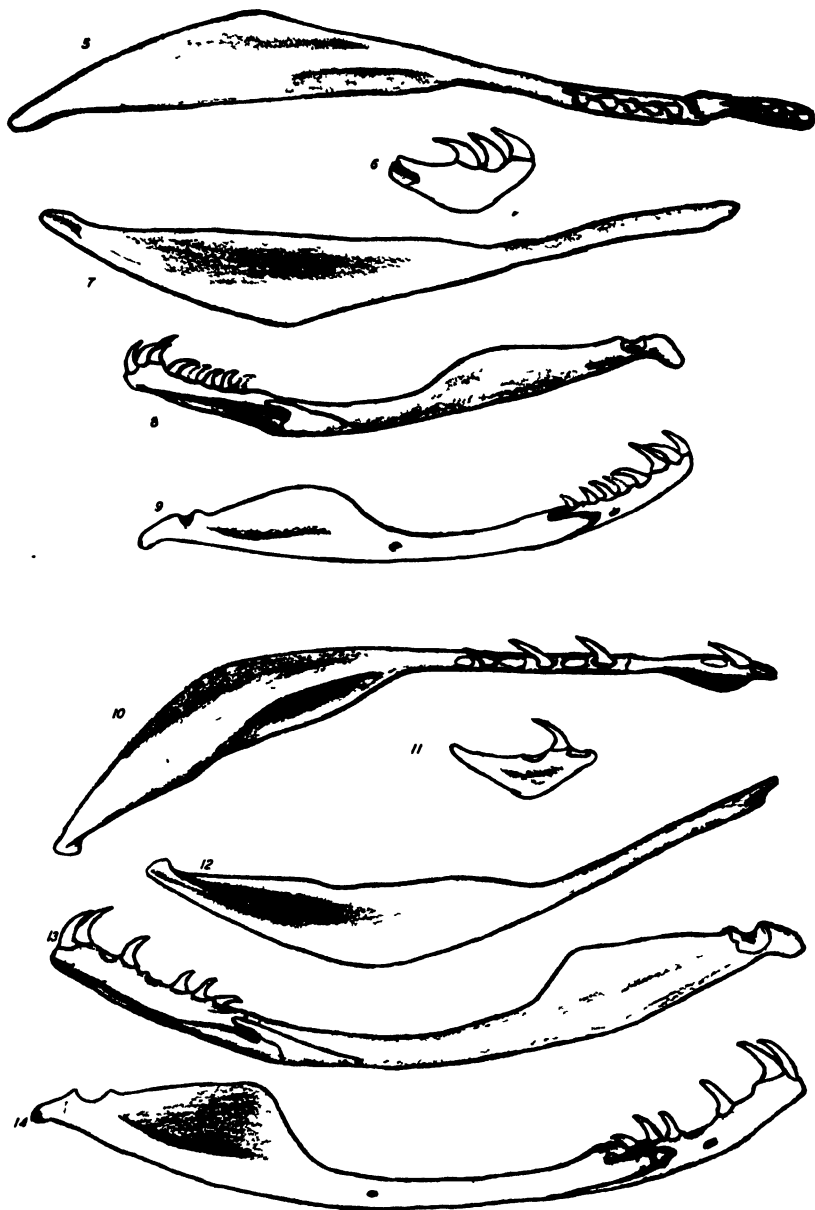


FIG. 5. Ventral view of right palatine and pterygoid of *C. g. lautus*. From USNM 110598, type.

FIG. 6. As in Fig. 5, lateral view of right palatine

FIG. 7. As in Fig. 5, dorsal view of right pterygoid.

FIG. 8. As in Fig. 5, medial view of right lower mandible.

FIG. 9. As in Fig. 5, lateral view of right lower mandible.

FIG. 10. Ventral view of right palatine and pterygoid of *C. t. triseriatus*. From EHT-HMS 21502, from Tacicuaro, Michoacán (*var. pallidus*).

FIG. 11. As in Fig. 10, lateral view of right palatine.

FIG. 12. As in Fig. 10, dorsal view of right pterygoid.

FIG. 13. As in Fig. 10, medial view of right lower mandible.

FIG. 14. As in Fig. 10, lateral view of right lower mandible.

There is an indication that at least one skeletal character may be correlated with the *omiltemanus* section, but since I have been able to check it only in *lautus*, no generalizations are advisable. One pterygoid bone examined of *lautus* bears 5 teeth (Fig. 5); on the other hand each of the 2 pterygoids of *pricei* and 6 of *t. triseriatus* bears 6 or 7 teeth (Fig. 10). Since the head is notably shorter in species of the *omiltemanus* subgroup than in other species (except perhaps *pricei*) the lesser tooth number is not surprising. Other differences, some very striking, occur in shapes and contours of the palatines, pterygoids and dentaries of the 3 forms examined, but their significance is not clear. The palatine, for instance, is very short in *lautus*, more elongate in *triseriatus*. In *lautus* the posterior end of the pterygoid lacks the peculiar, ridgelike process on the dorsal surface that is present in *triseriatus*; also the concavity on the dorsal surface is more central in position. In *lautus* the palatine articulates on the medial side of the anterior tip of the pterygoid, while in *triseriatus* the suture between the two appears (in ventral view) to be transverse. One of the characters believed to be most significant is the direction taken by the anterior border of the splenial ventral to the anterior meckelian foramen; in *triseriatus* it passes a considerable distance posteriorly, while in *lautus* it passes almost straight ventrally from the posterior border of the foramen. The flared dorsal border occupying the posterior third of the length of the dentary is more accentuated in *triseriatus* than in *lautus*. The depth of the angular notch in the dentary (as seen in lateral view), and the positions of the two lateral foramina, also differ. Other differences, which may be of considerable significance, can be discerned by making comparisons of the accompanying figures (Figs. 5-14).

Secondary characteristics. But little less significant than and almost if not quite as useful as the characteristics mentioned above are a number of others which find few exceptions. The supralabials are with rare exception 9; that number occurs elsewhere only in *pricei*, of the *triseriatus* group. The supralabial below the posterior border of the orbit is the 5th (Figs. 1-4, 18), while in all others of the group (Figs. 15-16), except *pricei* (Fig. 17), it is the 6th or 7th.

Of great interest in the entire group is the conformation of the nasal. This scale is always split (perhaps rare exceptions) in rattlesnakes, and perhaps for this reason has generally been treated as two separate scales—postnasal and prenasal. These terms, however, are in general use in other groups of reptiles for scales following or preceding, respectively, the nasal, which may or may not be split. The concept of the nasal is a scale in which the nasal opening is pierced; a vertical suture may split the scale into anterior and posterior halves, but these are still parts of the nasal, and are not prenasals or postnasals in the sense of being scales preceding or following the nasal itself. It is the usual procedure to refer to the parts of the divided nasal as the anterior or posterior section, but since this is clumsy and involves quite a few words the terms *pre-seminasal* and *postseminasal* are suggested.

In the *omiltemanus* subgroup, the postseminasal is always in contact with the first or first and second supralabials (Figs. 1-4, 18); this condition is found elsewhere in the group only in *pricei* (Fig. 17) and in rare *t. triseriatus* (Fig 15), and in none of even these is there contact with the second supralabial. It follows, and is true, that in the four forms of the *omiltemanus* subgroup (Figs. 1-4, 18);

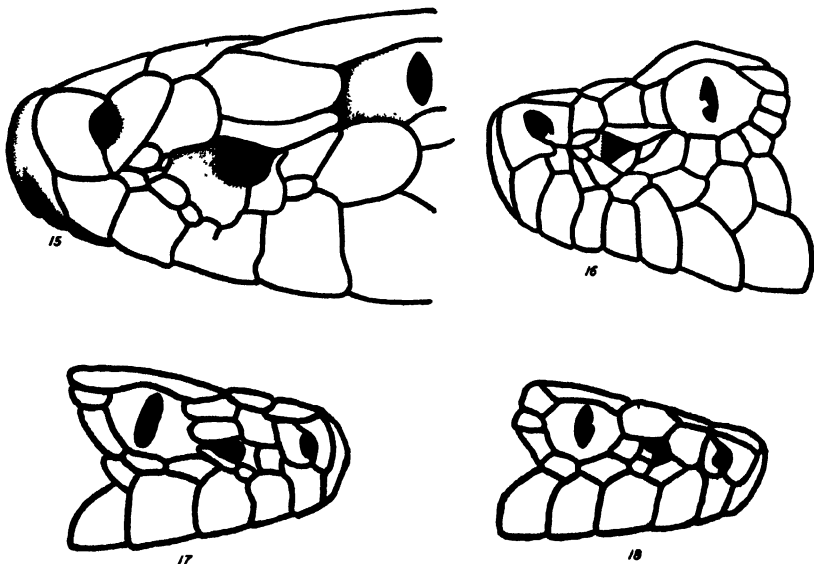


FIG. 15. Lateral view of orbitonasal region of head of *C. t. triseriatus*. From USNM 46465, Ameca, Jalisco.

FIG. 16. As in Fig. 15, *C. l. klauberi*. After Stejneger.

FIG. 17. As in Fig. 17, *C. p. miquihuanus*. After Gloyd.

FIG. 18. As in Fig. 18, *C. omiltemanus*. After Gloyd.

the lower border of the preseminasal is not produced posteriorly, while in *triseriatus* and *lepidus* (all forms of each) it is markedly produced posteriorly (Figs. 15, 16).

The dorsal border of the postseminasal may be in contact with the canthal and internasal, internasal only, or neither scale in the various forms of the *omiltemanus* subgroup (Figs. 1-4, 18); no one condition is necessarily constant for any one form. In *pricei* (Fig. 17), however, the dorsal border of the postseminasal is always (so far as known) in contact only with the internasal, while in *triseriatus* and *lepidus* (all forms of each) generally both canthal and internasal are contacted. Therefore the loreal may be in contact with both canthal and internasal, or with the canthal only, depending upon the nature of the nasal.

The loreal may in the *omiltemanus* subgroup be in contact with the labials, or it may be separated (Figs. 1-4, 18); in the latter case the separation is always by means of contact of the nasal and pit scales, never by subloreal.

Klauber (*loc. cit.*) states that a loreal is always present in rattlesnakes. Taylor (Univ. Kan. Sci. Bull., vol. 30, 1944, pp. 47-48, fig. 1) however, says the loreal is absent in *transversus*, and accounts for the extra scale by assuming it to be an anterior section of a divided upper preocular. Other specimens that have become available since Taylor made his study, however, show intermediate conditions that indicate rather conclusively that the scale in *transversus* is actually a loreal, not a part of a preocular.

The lower preocular is generally separated from the loreal, or split into two scales, in members of this section (not evident in figures). Only in *transversus* is the scale entire and in contact with the loreal. In all other sections of the group the scale contacts the loreal, and is very rarely divided (I have seen it divided in but one, a *t. triseriatus*).

A further characteristic is the reduced dorsal scale rows of the *omiltemanus* subgroup. All specimens have 21-17 (15) rows. In *pricei* the rows are usually 21 at the middle of the body, but in all others of the group 23 rows is the usual number.

Finally the body size is smaller, in general, in the *omiltemanus* subgroup; the head is likewise proportionately smaller, and the rattle smaller. In view of the characteristics cited there can be no question, I think, of the distinctness of the *omiltemanus* subgroup apart from the others of the *triseriatus* group. But as stated before the relationship to each other of the various forms in that section is not yet completely clear.

Status of forms. The form *omiltemanus* is one of the best differentiated of its subgroup, because of the high ventral count. No overlapping between its ventral counts (172 to 183) and those of other members of the subgroup (145 to 161) is apparent, and moreover only *klauberi*, of all other forms of the entire group, overlaps the counts of *omiltemanus* to any extent whatever (152-175). That character should then be given considerable weight, and because of it I regard *omiltemanus* as a species instead of a subspecies. The number of dorsal blotches (51 to 60) is also unique among members of the *omiltemanus* subgroup (others with 34 to 45); *anahuacus* and *pricei* (both forms), however, overlap this range completely. Moreover the character of the lower preocular is not absolutely unique (separated from loreal), as one specimen of *lautus* has been examined with a similar condition on one side, and the type of *gloydi* also has the scales separated.

Nevertheless the total characteristics of *omiltemanus* favor its consideration as a full species. Since there is some degree of continuity of ecological conditions (Fig. 20) between the areas occupied by *omiltemanus* and *gloydi*, however, the possibility of intergradation is not to be overlooked.

The remaining forms of the section comprise a compact unit of very uniform character. They are from distinct geographical areas: *gloydi* from Oaxaca, *transversus* from the Morelos-Mexico border, and *lautus* from the central Veracruz-Puebla border (see map, Fig. 20). The latter is known from 3 specimens, *transversus* from two, *gloydi* from one. The character of the loreal and postseminasal are generally to be considered of considerable importance in distinguishing the forms of the group, and in the present three some widely divergent types occur. In *gloydi* the postseminasal is greatly reduced and in contact with only the loreal, first labial and preseminasal, while in *transversus* it is the loreal that is greatly reduced, resulting in contacts of the postseminasal with the canthal, internasal, loreal, pit scale, first and second labials, and preseminasal. Two specimens of *lautus* from the border area of Veracruz and Puebla near Perote are rather like *gloydi* in this character, except that the postseminasal is a little larger and contacts the second labial and, in one specimen, the internasal. But a third specimen from the same area is exactly like *transversus* on one side of the head (Fig. 3), and approaches that condition on the other (Fig. 4). It cannot now be assumed that the latter specimen is of a different species than the other two specimens from the same area, and thus

one is forced to regard the nature of the loreal and postseminasal with suspicion in this subgroup until enough specimens are available to show the normal range of variation. The scales may be of great importance and of considerable constancy in other members of the group, yet in this subgroup some variation must be anticipated.

The form *gloydi* is distinguished from *lautus* and *transversus*, then, on the basis of the great reduction of the nasal (questionable), the separation of lower preocular and loreal (not infallible, also known on one side of some specimens of *lautus*), and upon the pattern (very similar to that of *lautus*). The type (which I have examined) has about 42 blotches on the body, and these are more or less quadrangular or oval in outline, covering 2 to 3 scale lengths and occupying 5 to 7 scale rows; they are separated from each by about one scale length. There is nothing in these characters to encourage regarding *gloydi* as a species distinct from *lautus*.

C. transversus has a mottled belly, and very narrow crossbands or spots 34 to 45 in number, which are split or almost divided on the middorsal line. Known specimens also have the postseminasal in contact with the pit scales, and the preocular in contact with the loreal; but one *lautus* specimen shows the same condition, in each category, on one side of the head. To this species I believe should be referred Martín del Campo's specimen (Anal. Inst. Biol., vol. 11. 1940, pp. 472-473, fig.) from Cempoala, Morelos. The form is more distinct from the other two than the latter are from each other, but only in pattern; and that pattern, particularly as exemplified by Martín del Campo's specimen, is not so remotely different from that of *lautus* that intergradation is not easily conceivable. Yet for the present, the greater degree of difference of *transversus* from *lautus* and *gloydi* leads me to regard the former a distinct species.

C. g. lautus has oval blotches, longer than in *transversus*, not interrupted at the middorsal line, and the belly is marked only with fine, scattered dark stippling. The postseminasal is reduced but in contact with 2 labials, and may or may not be in contact with the pit scales and with the internasal alone or both the internasal and the canthal. The relationship with *gloydi* appears to be very close and that with *transversus* is scarcely less so.

PRICEI SUBGROUP

The two forms of this species are associated together on the basis of morphological and patterns similarity, and geographic probability. Each has a single subloreal (Fig. 17), contrary to the *omil-*

temanus subgroup which has none (Figs. 1'-4, 18), and the other subgroups which normally have several. The supralabials are usually nine, and the fifth lies below the posterior border of the orbit, as in the *omiltemanus* subgroup, and thus the species is a rather short-headed one. Of great significance is the fact that the preseminal is not produced at its ventral border, but is in contact with only about the anterior half of the upper surface of the first supralabial (Fig. 17); in *triseriatus*, *lepidus* and *semicornutus* the border is so prominently produced posteriorly that it nearly or quite reaches the second supralabial, generally (Fig. 16) separating the postseminal from the labials (not always, Fig. 15). Likewise in *pricei* the postseminal is in contact above only with the internasal, while in *triseriatus* and *lepidus* the scale generally touches both canthal and internasal. The scale rows are generally twenty-one medially in *pricei*, twenty-three in *triseriatus* and *lepidus*. These are the chief characteristics by which the two forms differ from others; and there can be no question that together they comprise a distinct species. The species finds its closest relatives at least so far as external characters are concerned, not in *triseriatus* but in the *omiltemanus* subgroup. *C. transversus* approaches it most closely in pattern. The characters of the pterygoid, palatine and lower jaw bones, however, approach or duplicate those of *triseriatus*.

TRISERIATUS SUBGROUP

The preceding discussion has brought out differences between *triseriatus*, *pricei*, and the *omiltemanus* subgroups. The chief features mentioned that define *triseriatus* as a species are the numerous (10 or more) supralabials; 6th, 7th and 8th labial below posterior border of orbit (Figs. 15, 16); several (rarely one) subloreal (Figs. 15, 16); postseminal generally in contact with canthal and internasal (Fig. 15); preseminal produced posteriorly (Fig. 16); 23 or 25 scale rows at middle of body. In addition the dorsal blotches on the body are not less than 25. The species is completely and well differentiated from others of its group.

The two forms of the species are rather clearly subspecies, as their characters overlap and they occupy adjacent ranges. The chief differences between *t. triseriatus* and *t. anahuacus* are in number and size of dorsal blotches, and in number of ventrals. The latter has more numerous oval blotches (usually 40 or more, *triseriatus* with usually less than 40 quadrate blotches) and fewer ventrals. Specimens now referred to *t. triseriatus*, however, may represent still other forms not now clearly distinguishable.

The closest relatives of *triseriatus* are not in the previously considered forms, but in *lepidus*. There is a great similarity between the two species, and I believe it indicates relatively close relationship. The frequent occurrence of a divided upper preocular in *triseriatus* links it with *lepidus*, as does the curious form of the nasal, the several subloreal, the numerous supralabials, and the numerous scale rows. Klauber (Copeia, 1940, No. 3, pp. 206-207) refers to differences in hemipenial structure, but in external features, the two species are so alike that one specimen from Santa Teresa, Nayarit (U. S. Nat. Mus. No. 46333) is the subject of some disagreement as to which species it represents. Gloyd (*op. cit.*, p. 87) places it in *t. triseriatus*, while I would call it a *l. klauberi*. It has only 22 cross-bands on the body (including the occipital band), and although these are narrow (occupying only 5 to 8 scale rows) except near the tail, they are spaced and shaped as in *lepidus*, and are serrate-edged as in that species. Since the known minimum in *triseriatus* is 25 body blotches, while the range in *lepidus* is 14 to 23, the specimen falls best in *lepidus*, whose pattern it matches in other respects. It resembles *triseriatus*, however, in the gray-brown ground color, the very dark belly and chin, and the absence of a division in the upper preocular. Since apparently all other *lepidus* invariably have the upper preocular divided, this exception is extraordinary. Unfortunately the specimen is a female, so no comparisons of hemipenes are possible. In view of the variability of the head scales, I prefer to follow the indication of the pattern in allocating the specimen to *lepidus*. It does not, however, agree completely with the form of *lepidus (klauberi)* known from the same general area, for it has a dark postocular stripe and a darkly mottled belly (no stripe, belly nearly or quite immaculate in *klauberi*). Altogether the specimen appears quite intermediate in character between *triseriatus* and *klauberi*; it may represent a distinct race or species, or, of course, a hybrid. Further specimens will be necessary to arrive at a definite conclusion. In any event the postulate of a close relationship between *lepidus* and *triseriatus* is given strong support by the specimen.

SEMICORNUTUS SUBGROUP

This recently described form is almost as much of a puzzle as the preceding specimen from Nayarit. The single known example is unique in the development of the supraocular, but in most other respects is very similar to *lepidus*. The blotches resemble those of the other species of the *triseriatus* group rather strongly, as they

are about equally as long as broad. The species evidently demonstrates a pattern that may be close to the ancestral type of *lepidus*, for it is clear that the latter form must have been derived from something with blotches not unlike those of *triseriatus*.

III

ZOÖGEOGRAPHY AND EVOLUTIONARY DISCUSSION

The arrangement of pattern types in the *triseriatus* group suggests that *semicornutus* is the most primitive of all forms of the group in pattern. It is not, it would seem, primitive in scutellation, but is rather the most highly modified of the group. The situation requires explanation.

Migration waves. As has long been urged by many zoögeographers, and as reëmphasized by Schmidt (Amer. Midl. Nat., vol. 30, 1943, pp. 241-253), in the course of evolution of animals upon the American continents a succession of waves of more and more advanced forms radiated outward from a center of distribution in the north. Thus an aggregation of primitive forms at, for instance, the southern edge of the Mexican plateau, is not to be interpreted as indication that the edge of the plateau is a center of distribution; rather it indicates the extreme periphery of distribution of the several groups represented. The *triseriatus* group appears to fit this distributional law. The most primitive forms (*omiltemanus* subgroup) are at the extreme periphery of the range of the group (Fig. 19); they together can be visualized as the present-day counterparts of the primary portion of the first wave (IA of Fig. 21) of migration from some northern center of dispersal. As a secondary portion (IB of Fig. 21) of the first wave, the *pricei* subgroup followed the *omiltemanus* subgroup, but because of close relationship, as a member of the same wave movement, never over-ran the primary portion. Some time elapsed before a second wave, carrying along as its primary portion (IIA of Fig. 21) the *triseriatus* subgroup, migrated southward, eliminating most evidence of the first wave except in the Oaxaca and Guerrero regions, which may by that time have become inaccessible. The secondary portion of the second wave (IIB of Fig. 21) carried *lepidus* in its wake, and perhaps a tertiary portion (IIC of Fig. 21) carried *semicornutus*. Thus the picture of waves of migration might be represented as in figure 22. The number of waves, their relative importance and their temporal distinctness are purely a matter of conjecture and may well be in

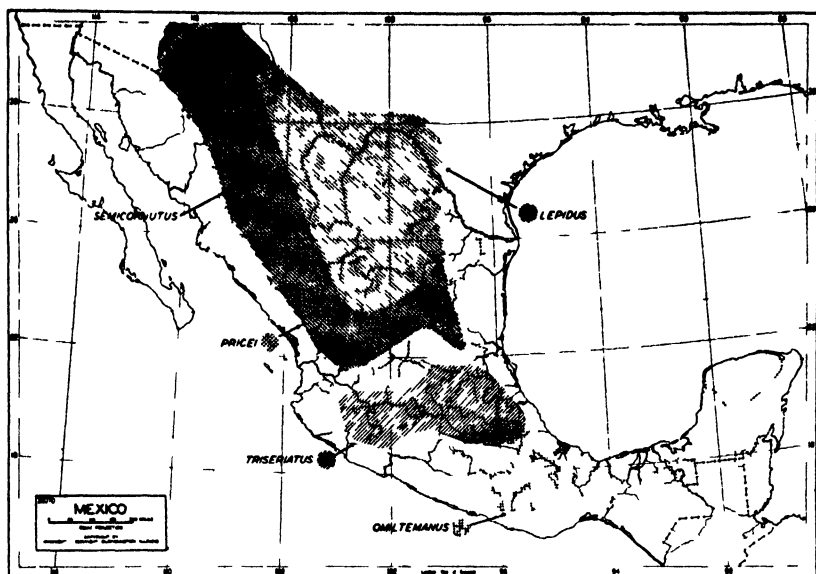


FIG 19 Distribution in Mexico of the five subgroups of the *triseriatus* group

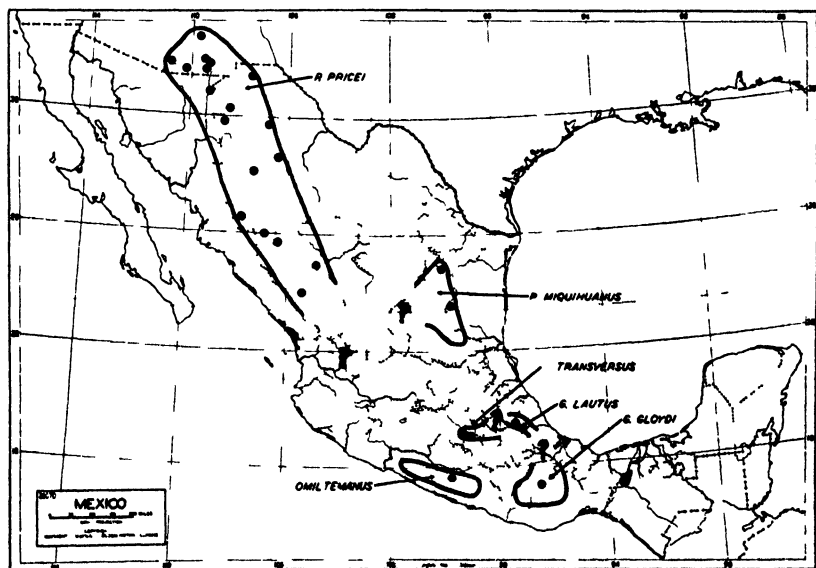


FIG 20 Distribution of the members of the two primitive subgroups (*pricei* and *omiltemanus*) of the *triseriatus* group

error. The succession is, however, fairly well established and it is only this that can at present be considered of significance.

Orthoevolution in scutellation. In each successive wave and wavelet of this migration an increasing modification of head scales and general external character is clearly evident. The members of the first wave (IA) are the least modified beyond a typical snake condition, while the member of the last wave (IIC) is the most highly modified of all. This is a trend which may be described as orthoevolutionary, for the modifications of each successive wave have been along the same lines almost without exception. The term orthoevolution is not used here as an explanation of the phenomenon but simply as a brief way of referring to the character of evolution in these particular features—a single-line evolution rather than a haphazard one. To what the phenomenon is due—whether selective mutation (orthogenesis) or selective elimination (orthoselection)—is not for speculation here. There is a suggestion, however, that regardless of the means, environment plays an important role in it.

The existence of an orthoevolutionary trend such as is evident in the scutellation of the *triseriatus* group cannot be explained as something inherent in the germ plasm of the group. Were that the case the oldest forms, of wave IA, would be the most highly modified of all. Clearly the modification must be dependent upon the geographic center of origin of the group. Thus the longer the animals remain in that center, the greater their modification along the specified line; and the sooner they leave, the less the modification will be. This statement agrees perfectly with the idea of waves of outward migration; members of wave IA, having left the center of origin earliest, were least changed, while that of the last wave (IIC) to leave that center was the most changed. Thus it is apparent that in this orthogenetic trend the most important factor is the existence of the animal in a certain geographical area in which the changes are being produced; outside of it the changes, at least in that direction, cease.

Pattern orthoevolution. There is a second orthoevolutionary trend, and that is in pattern. It is not so well defined as the trend in scutellation, but clearly exists. The members of wave I have relatively numerous and small blotches, with extremes in *omiltemanus*, *transversus* and *pricei*. The members of wave IIA have relatively fewer, but *anahuacus* closely parallels some members of wave IA. The forms of wave IIB have still fewer, and that of IIC least of all. The trend exists, but the direction of the trend—

whether from a primitive pattern with few blotches or one with many—is not immediately obvious. If the procedure in this case is like that in regard to scutellation, then the least modification occurs in the peripheral forms, the greatest in the most central.

But, I believe, the procedure has not been the same in pattern as in scutellation. If what is primitive in pattern were generally known, as is the primitive scutellation, there would be no doubt of

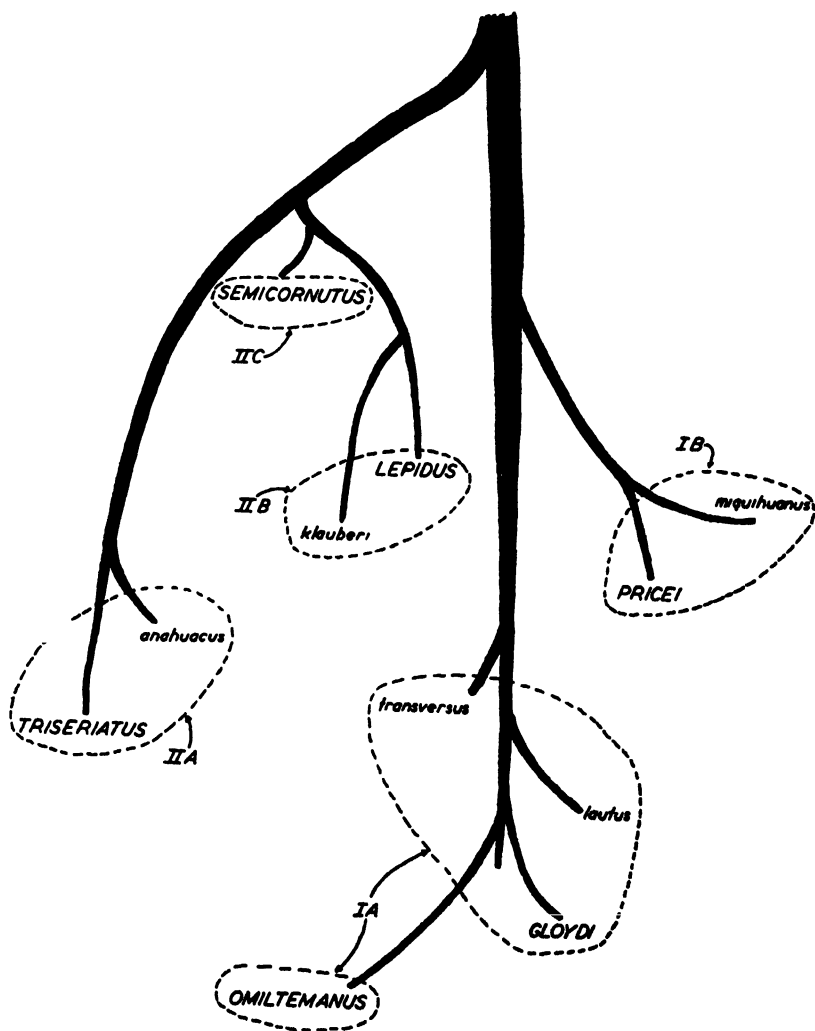
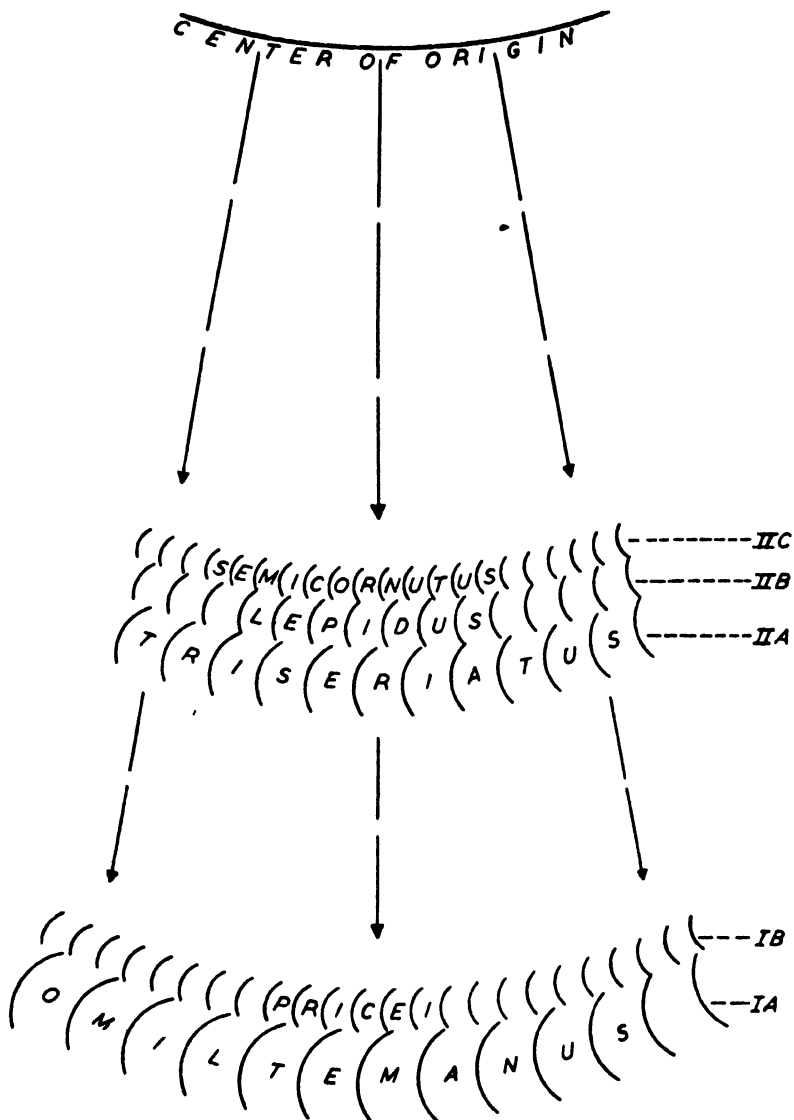


FIG. 21 Possible phylogeny of the forms of the *triseriatus* group.



22

FIG. 22. Diagram of migration waves in the *Triseriatus* group.

the direction of the trend. Herpetologists have not generally agreed, however, upon the type of pattern that is primitive for snakes in general or for rattlesnake ancestors. In the absence of such knowledge we must try to determine what is primitive in the present case.

Three lines of evidence point toward the condition of few blotches as primitive.

First, there is little difference between some members of wave IIA and some of wave IA. *T. anahuacus*, for instance, is strikingly similar to *lautus* and *gloydi*. Yet waves I and II are strikingly different in scutellation. If the change was going on only in the center of origin (as in the case of scutellation) there would have been difference between the various waves equally as great in pattern as in scutellation. That there is not suggests that pattern changes occurred *after* migration away from the center of origin, although at different rates in the different waves. In such case it is reasonable to assume that the changes may continue at a more or less constant rate outside of the center of origin, and that the accumulation of change will be greatest in the forms which have been longest away from that center. By this line of evidence a primitive pattern of few blotches is suggested.

A second line of evidence is the lack of constancy of pattern within the members of one wave. In the *omiltemanus* subgroup, for instance, there is a rather considerable range of variation from almost the maximum number of blotches known in the group to a median number of some 34. Since these are all derived from one common wave-stock, it is clear that these changes in pattern occurred *after* migration to their present geographic zone. We know then that pattern evolution is not *limited* to the center of origin, and that it has progressed to a considerable degree outside of that area. Thus one is led to the same line of reasoning that was followed in discussion of the first point above.

Finally, those monographs which have dealt with the problem of pattern evolution in snakes have indicated that the trend, in blotched colubrids at least (from which the vipers presumably were derived) the primitive pattern is one of few, small blotches. The pigmented area tends to increase, either by increase in number or in size of the blotches. Increase in number may result only in a shattering and reduction in size of the spots (as in *pricei*), to preserve a certain constant of nonpigmented area (seemingly a very important factor in pattern evolution). On the other hand, it may result in a crowding and a *sudden* reduction in number of blotches by elimination of alternate marks. A second increase may follow, and then another sudden decrease in the same fashion, and so on. The blotches may expand laterally into rings instead of, or as well as, increasing in number. Should increase in *size* of the blotches be the direction of

pigment expansion, instead of increase in number, then a longitudinal fusion and shattering may result, suddenly producing a striped pattern, which then goes through its own line of evolution. That all colubrids have followed this line of blotch evolution does not necessarily follow; that of *Coluber* and *Masticophis* is not readily comparable. But at least there is a parallel phenomenon in some Colubrids and in the *triseriatus* group; and that the parallelism may be of profound nature is a tempting speculation.

Positive and negative orthoevolution. If it be granted that the primitive pattern, for the *triseriatus* group, is one with few, small blotches, then it may be seen that the orthoevolutionary trend in pattern is the *reverse* of that in scutellation, for the earliest wave has the greatest instead of the least change, and the latest wave has the least instead of the greatest change.

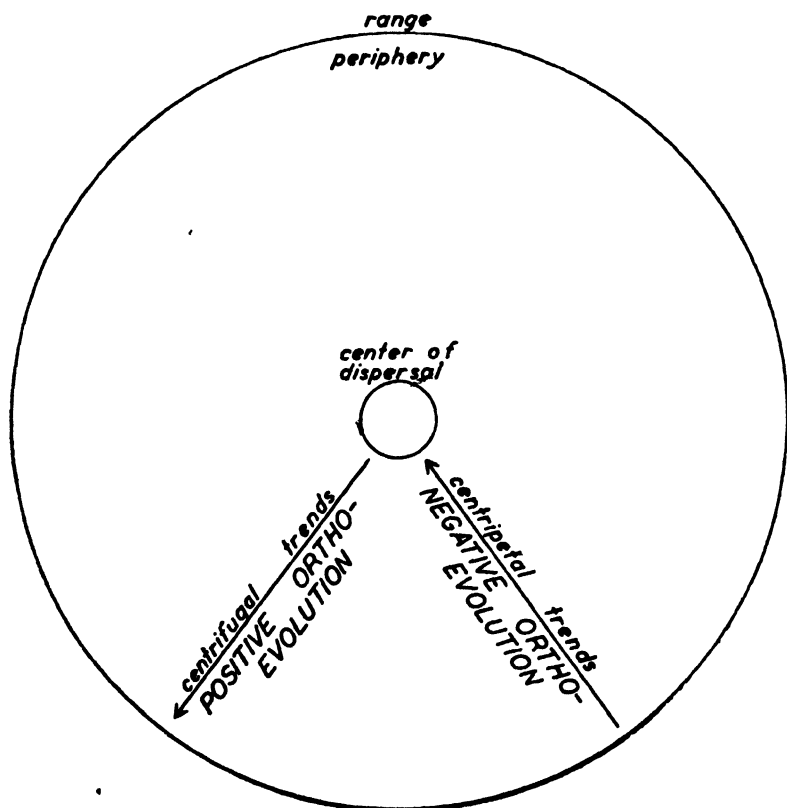


FIG. 23. Diagrammatic representation of the concept of positive and negative orthoevolution.

Thus we are concerned in pattern and scutellation with two phenomena of diametrically opposed nature—one which might be called “positive” orthoevolution (pattern), the other “negative” orthoevolution (scutellation) (Fig. 23). Negative orthoevolution may be defined as an evolutionary trend whose manifestation is dependent upon a certain limited environmental situation; it is of relatively localized occurrence. Positive orthoevolution is conceived as an evolutionary trend whose manifestation is independent of most (not necessarily all) environmental conditions; it is of relatively general occurrence.

Environmental effects. It is clear that pattern evolution continued outside the center of origin, while scutellation evolution did not. Pattern change did not occur at all times, *both* within and without the center of evolution, else all forms would be more or less alike. Given that the most primitive pattern occurs in or near the center of origin, it follows that pattern evolution occurred only or for the most part, *outside* the center of origin.

We conclude then that under the conditions existing over many thousands of years in the center of origin of the *triseriatus* group, and *only* within that area, a constant series of mutations occurred and were preserved to produce a steady orthoevolutionary trend in scutellation changes. In that area no pattern changes occurred. However, as the populations carrying these characters spread beyond the limits of this center of origin, the mutations for scutellation change ceased, and in their stead appeared another orthoevolutionary trend in mutations affecting pattern. Clearly some environmental factor operated in one place that did not in another, and its role was an important one in rattlesnake evolution. The means whereby its influence was effected is not evident.

It is interesting to conjecture that the mutation rate in the rattlesnakes discussed is more or less constant at all times, and that only the nature of the mutations is influenced by the environmental factors; and likewise that positive orthoevolution concerns survivally important characters, while negative orthoevolution involves characters of no selective value.

Matthew versus Adams. The main body of evidence derived from these rattlesnakes supports Matthew's main premise in *Climate and Evolution* of successive waves of migration from a northern center of dispersal. But it also shows that his second premise of peripheral occurrence of primitive forms is not wholly or always true. Certainly the peripheral forms are the earliest migrants; in

this respect they are the most primitive. But Matthew did not use the term "primitive" in just that sense. He meant that the peripheral forms not only were of the earliest waves of migration but also carried the most primitive *characters*. From the above discussion it is apparent that this is not always so. Whether the peripheral forms are the most primitive in all respects depends upon the nature of the orthoevolutionary trends. If they have been in the past of local character (negative orthoevolution) then there will be no or little further change as the wave migrates peripherally. But, if positive orthoevolution occurs in some character, then the forms near the center will be the most primitive in that character. Peripheral modification, with a central primitive stock, is essentially the prime thesis of Adams' theory of group evolution. These two principles—of Adams and of Matthew—have been generally regarded as diametrically and unalterably opposed to each other. In reality they operate hand in hand, neither to the exclusion of the other, as two consistent phases of species evolution.

Primitive versus early. It is evident that the earliest migrants from the center of dispersal of the *triseriatus* group are not in all respects the most primitive. They are held in that light by most investigators because they actually are primitive in certain conspicuous characters that are usually held as important. Yet in other respects the *omiltemanus* subgroup is highly modified. The association of primitive with highly specialized characters in a single form or group is commonly known in many groups of animals, yet in spite of this fact they are continually referred to as "primitive" species. In reality the modified characters may be more numerous than the primitive ones; it is only the subjective evaluation of them that can lead one to assume that more characters, or more important ones, are primitive than modified. Obviously one should refer to primitive or modified *characters*, not primitive or modified *species*. The species is the carrier of the characters; it is neither primitive nor modified, although it may be referred to as such if its characters are preponderantly or notably of one type or the other. Actually the species should be referred to as an *early* or *late migrant* or *divergent*; in that expression is conveyed the expectation of a certain proportion of primitive or modified characters.

IV

SUMMARY

The *triseriatus* group of *Crotalus* consists of 11 forms, as known at present, belonging to 6 species and four subgroups. The most primitive subgroup includes *omiltemanus*, *gloydi gloydi*, *g. lautus*, and *transversus*, all forms at the southern periphery of the Mexican plateau. That section comprises the remnants of the first of a series of perhaps 5 successive waves of migration from a northern center of origin. The second wave, closely following the first and of next most primitive forms included what is now *p. pricei* and *p. miquihanus*. A third wave, at a considerably later date, included *t. triseriatus* and *t. anahuacus*. A fourth wave, closely following the third, included *l. lepidus* and *l. klauberi*, while a fifth wave, following closely the preceding, included *semicornutus*.

The ancestral stock remaining in the center of origin during the periods of occurrence of migration waves mutated in such a fashion as to produce an orthoevolutionary trend of scale modification; these changes ceased in any part of the stock which migrated peripherally, so that later waves had evolved farther in this respect than the earlier waves. However, as the scale mutations ceased, pattern changes were initiated and perpetuated thereafter at a more or less (not completely constant) rate, so that in this respect earlier waves evolved to a greater degree than later waves.

The course of scale evolution is considered an example of *negative orthoevolution*, defined as an evolutionary trend whose manifestation is dependent upon a certain limited environmental situation; it is of relatively localized occurrence. The course of pattern evolution is considered as an example of *positive orthoevolution*, defined as an evolutionary trend whose manifestation is independent of most (not necessarily all) environmental conditions; it is of relatively general occurrence.

Either or both types of orthoevolution may occur in the development and distribution of any group of animals; probably generally both types occur. Predominance of negative orthoevolution in the history of any given group would result in a peripheral concentration of predominantly primitive forms (Matthew's principle) while predominance of positive orthoevolution would result in peripheral concentration of predominantly "higher" forms (Adams' principle). Thus these two apparently opposing principles are, then, to be con-

sidered not as mutually exclusive ideas, but as coöperatives of equal importance in the history of animal evolution, although it may be true that Matthew's principle of negative orthoevolution is predominant in frequency of occurrence in the history of many given sets of characters (*i. e.*, species).

The primitive pattern of the *triseriatus* group is considered to consist of few, small, median dorsal blotches.

The term *subloreal* is introduced for the scales between the loreal and supralabials, and between the nasal and pit.

The two halves of the nasal are termed *seminasals*, the anterior half as the *preseminasal*, and the posterior half as the *postseminasal*.

V

KEY TO FORMS OF THE TRISERIATUS GROUPS*

1. No subloreal: loreal in contact with labials or, if separated from labials, the interposed scales are the nasal and scales entering the pit; posterior section of nasal in contact with 1 or 2 labials; scale rows 21-21-17 (15); keels scarcely evident on posterior dorsal head scales; head very small..... 2
One to three subloreal intervening between loreal and labials; posterior section of nasal not in contact with labials, or only with 1st labial; scale rows usually 23 or more anteriorly or medially, seldom 15 posteriorly; keels usually distinctly more pronounced; head larger 5
2. Ventrals 172 to 183; dorsal spots small, 51 to 60; lower preocular widely separated from loreal *omultemanus*
Ventrals fewer; dorsal spots fewer; lower preocular (sometimes transversely divided) in contact with loreal or not..... 3
3. Nasal in contact with only 1st supralabial; postseminasal much reduced in size, $\frac{1}{4}$ or less the size of preseminasal; latter in contact with loreal above; lower preocular separated from loreal; latter in contact with 1st and 2nd supralabials. *gloydii gloydii*
Nasal in contact with 1st and 2nd supralabials; postseminasal large or small; preseminasal in contact or not with loreal above postseminasal; lower preocular rarely in contact with loreal; latter in contact with one or no labials; spots oval or transverse bands 4
4. Dorsal pattern consisting of small, transversely oval, median blotches; loreal generally (?) in contact with supralabials; lower preocular generally (?) divided. *gloydii lautus*
Dorsal pattern of paired spots which may be expanded laterally into transverse bands, but which do not cross the median line; loreal separated from supralabials; lower preocular single *transversus*
5. Median dorsal bands or blotches less than 24 on body; upper preocular rarely not vertically divided; anterior section of nasal produced posteriorly below naris to a point beyond a line even with the posterior edge of the naris..... 6
Median dorsal bands or blotches more than 24 on body; upper preocular usually not vertically divided; anterior section of nasal may be produced posteriorly below naris, but does not extend so far..... 8
6. Supraocular markedly elevated; dorsal spots 17 on body, not band-like (except the extreme posterior), each 5 to 8 scale rows in width, most about as long as broad; caudals 20 in a male..... *semicornutus*
Supraoculars round; dorsal spots 14 to 23, all generally band-like, much broader than long when visible; caudals in males over 20; supraocular not elevated..... 7

* Based partly on Gloyd (*op. cit.*).

7. A dark stripe from orbit to angle of mouth; a pair of separate occipital blotches; body pattern of transversely expanded dark blotches or crossbands, interspaces frequently with secondary blotches or bands but little darker than ground color.

lepidus lepidus

Dark stripe from orbit to angle of mouth obsolete or absent; occipital blotches united; body pattern of conspicuous dark brown or black crossbands, interspaces greenish gray or bluish gray with small dark flecks or indistinct gray blotches.

lepidus klauberi

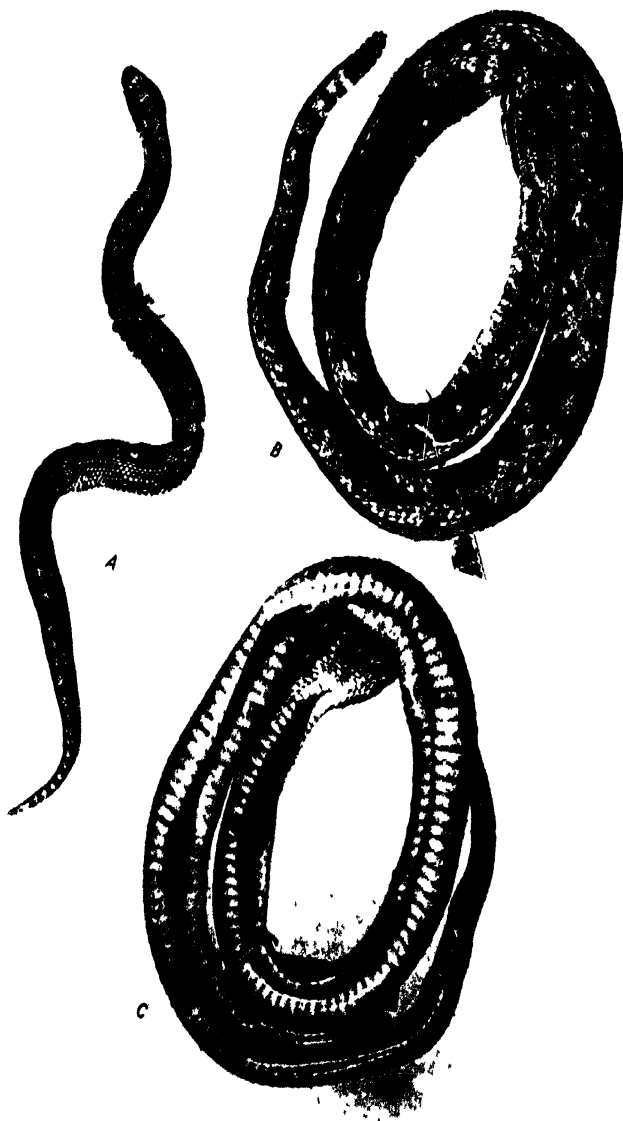
8. Ventral edge of preseminal extending as far posteriorly as dorsal, or farther; post-seminal in contact with both canthal and internasal; generally two or more sub-loreals; six or more supralabials to below posterior edge of orbit; pattern of median blotches, but general color sometimes very dark or very light; upper preocular sometimes split transversely; scale rows generally 23 medially..... 10
 Ventral edge of preseminal not extending as far posteriorly as dorsal edge; post-seminal not in contact with loreal, only with internasal; generally one subloreal; five supralabials to below posterior edge of orbit; pattern of small, paired dorsal spots, sometimes fused medially; upper preocular seldom divided transversely; scale rows 21 medially 9
9. Ventrals more than 150; general coloration usually gray; dorsal spots usually separate, in pairs *pricei pricei*
 Ventrals less than 150; general coloration predominantly brown; dorsal pairs of spots often connected medially *pricei miquhuanus*
10. Body pattern of relatively large, quadrangular spots 25 to 46 in number, usually less than 40 *triseriatus triseriatus*
 Body pattern small, elliptical spots (median) 39 to 57 in number.

triseriatus anahuacus

PLATE III

PLATE 1. *Crotalus gloydi lautus*. A, paratype, EHT-HMS No. 5475. B-C type, U.S.N.M. No. 110598

PLATE III



THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

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MAY 1, 1946

[No. 4

The Status of *Sceloporus floridanus* Baird

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ABSTRACT: Evidence is presented to show that the name *Sceloporus floridanus* Baird should be allocated with the Florida sub-species (*undulatus*) of *S. undulatus*, and not with the Texas relative (*S. olivaceus*) of *S. spinosus* as indicated by the Stejneger and Barbour Check List

THE 1943 edition of the Stejneger and Barbour Check List of North American Amphibians and Reptiles presents a new interpretation of the identity and validity of Baird's *Sceloporus floridanus* (Proc. Acad. Nat. Sci. Phila., 1858, p. 253), whereby the discrepancy between the stated type locality (Pensacola, Florida) and the range concept which accompanies allocation of that name to the Texas relative of *Sceloporus spinosus* is explained by assuming an incorrect statement of the type locality. Since the Texas species referred to is not known east of Texas, identification of the type of *floridanus* (fortunately extant, U. S. National Museum No. 2874) with that species would necessitate either the above assumption or the very unlikely one that the Texan form does occur eastward to Florida but has simply not been collected east of Texas save for the type. While the name has long been associated with the Texan form (by most authors ever since Stejneger so identified it in 1893), only within the past ten years has the concurrent geographic discrepancy been generally apparent, and now for the first time is proposed a reasonable reconciliation of apparently inconsistent facts.

There is another means of reconciliation, however, by associating the name with the form of the *undulatus* group which occurs in the region of the type locality; this was first proposed in 1936 by Burt (Trans. Kan. Acad. Sci., vol. 38, pp. 277, 281). Subsequent articles by the same author (Papers Mich. Acad. Sci., Arts., Lett., vol. 22

1936 (1937), pp. 535-536; Trans. Kans. Acad. Sci., vol. 40, 1939, pp. 353-354) reveal a maintenance of the same opinion, and with the major premise concurrence of opinion was expressed by other authors, including myself (Occ. Pap. Mus. Zool. Univ. Mich., no. 387, 1938, pp. 7-8; Zool. Ser. Field Mus. Nat. Hist., vol. 26, 1939, pp. 110-116). Such an allocation releases the Texan form from the name *floridanus*, and makes valid for it the later name of *olivaceus* Smith. However the Stejneger and Barbour Check List uses the name *spinosus* for the Texan form, as did Burt, although it has been pointed out repeatedly that the Texan form (which occurs also in northern México) differs widely from *spinosus* of central México. The Check List therefore uses two names, *S. floridanus* and *S. spinosus*, for the same species. Since in the preceding (4th) edition the former name was used for the Floridan form, and *spinosus* for the Texan, it may be assumed that it was the intention of the authors to delete reference to *spinosus* upon reallocation of the name *floridanus*.

Since the type of *floridanus* is extant and in good condition, one might assume it would be a simple matter to determine which of two species as clearly distinct as *olivaceus* of Texas and *undulatus* of Florida it represents. The difficulty in making a definite statement is due largely to the unfortunate fact that there is no infallible morphological character known as yet that will distinguish the two (except size). The sharpest differences are chiefly in color; in addition *olivaceus* is much larger, but specimens of intermediate sizes are not to be determined by this character. There can be no question of the distinctness, as species, of the Florida and Texan forms, but individual specimens of moderate or small size (less than 80 mm. snout to vent) can be distinguished at present best by color.

The color of the type of *floridanus*, a male measuring 75.5 mm. snout to vent, fits the usual pattern of neither form very well. A male specimen of comparable size of either species should have the very clearly defined ventral markings characteristic of that sex, yet the belly of the type is "immaculate save a few black striations in the chest region and a longitudinal line between hind legs" (personal notes, 1934). Therefore we can assume with some degree of certainty that *some* fading has taken place, and the dorsal surface bears out this assumption, for "dorsal markings are absent, except the sides appear darker than the back; a vertical black mark from shoulder to lateral neck fold." However, of most importance is the *extent* of fading which would be necessary to bring a specimen of

comparable size of either species to an appearance like that exhibited by the type.

Males of the Florida form seldom reach the size of the type, but I have seen two of approximately the same size, out of 81 examined (Univ. Mich. No. 76436, Natchez, Adams Co., Miss., 77 mm.; and Univ. Mich. No. 47585, Washington, Adams Co., Miss., 74 mm.). It is remarkable that in this form the males at least equal if they do not exceed the females in size; the largest female in seventy-three examined measured 72 mm. (Charleston Mus. No. 31. 233 Cottageville, Colleton Co., S. C.). In the larger series examined of the more northern race (*u. fasciatus*), several specimens of both sexes were found to equal or exceed 75 mm. Therefore on size alone the type cannot be excluded from identity with the Florida form. The Texan form, of course, reaches a still greater size (97.5 mm. recorded for males, 121 mm. for females). But males of the Florida form, at such a large size, would be extremely dark below, while those of the Texan form would have but few, scattered, black streaks in addition to the bluish lateral belly patches and throat. The amount of fading necessary to bleach a large Florida male would be much greater, then, than the amount required to bleach a specimen of *olivaceus*, and in fact it would seem well-nigh impossible to bleach an *undulatus* so completely without rendering it uniform white. Yet I believe this occurred, and the belief is based upon the presence of the dark shoulder blotch. This mark, clearly, must have been one of the darkest spots on the lizard to have remained while other pattern features were lost. Now *olivaceus* has no distinctive shoulder patch; a dark mark which does occur there is relatively small and is cut off dorsally by a light longitudinal band, is usually scarcely larger and darker than other blotches on the sides of the back, and generally does fade quickly in formaldehyde; *undulatus*, on the other hand, does have a very dark, large, unbroken shoulder patch, which is one of the earliest pattern marks to appear in development, and might well be expected to be among the last to disappear in the bleaching process.

Other notes taken on the type of *floridanus* are as follows:

Supraoculars 5-5, separated from median head scales, and from superciliaries by one row on one side and on the other by one complete and one incomplete row; frontal in contact with interparietal and median frontonasal; anterior section of frontal divided; two canthals, the first touching lorilabials on one side (fused with loreal); preocular not divided; lorilabials reduced to one row at a point be-

low subocular; outer row of labiomentals not in contact with mental; auricular lobules elongate, 5-5. Scales on back rather strongly keeled, mucronate, denticulate; ventrals strongly notched; scales on posterior surface of thigh much smaller than preanals, smaller than those preceding femoral pores; pores 13-15. Dorsal scales, 31; scales around middle of body, 33; 53 ventrals; a few modified, pore-like preanal scales; snout to vent, 75.5 mm.; snout to occiput, 13.5 mm.; snout to posterior border of ear, 17 mm.; hind leg, 57.6 mm.; fourth toe, 22.3 mm.; fifth toe, 10 mm.; tibia, 15 mm.; 5.7 dorsal scales to head length; lamellae on fourth toe 23-24; tail, 126 mm.

Three points mentioned in the above description are of special interest. First, in only 4 out of 100 *olivaceus* was the anterior section of the frontal found divided; it is frequently divided in *undulatus*, and is in the type of *floridanus*. Second, in 54 specimens of *olivaceus* 52 was the maximum ventral count; the type of *floridanus* has 53 (no data for *undulatus*, but a higher range is to be expected). And finally, according to my observations, the preanal scales are modified with porelike structures only in the very large and old males of a species; it is not a phenomenon of frequent occurrence in any *Sceloporus*. A snout-vent measurement of 77 mm. in *olivaceus* is that of a young male which would definitely not be expected to have preanal "pores"; while the same measurement in *undulatus* is that of a very large male, in which preanal "pores" could reasonably occur.

Therefore it may be concluded that, while completely convincing evidence is lacking, there is strong evidence on the basis of color, subdivision of the frontal, ventral count and preanal "pores" that the type of *floridanus* belongs to *undulatus* rather than to *olivaceus*, and that on no count is there a stronger indication toward *olivaceus* than toward *undulatus*. The type locality of *floridanus* is therefore to be accepted as stated, and the name should be considered a synonym of the older *undulatus*, based upon the same form. The proper name for the Florida form is then *Sceloporus undulatus undulatus* (Latreille), and that of the Texas form *Sceloporus olivaceus* Smith.

THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

VOL. XXXI, pt. I.]

MAY 1, 1946

[No. 5

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A Review of the Genus *Calipyrgula* Pilsbry (Gastropoda: Amnicolidae)

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ABSTRACT: The seven species now assigned to the genus *Calipyrgula* Pilsbry are compared, figured to scale, and variations and measurements are given; locations of types, type localities, and horizons are recorded; and speculations upon the distribution of this unique Pliocene gastropod genus are included.

AT present seven species are assigned to the genus *Calipyrgula* Pilsbry which was proposed to accommodate three species of minute amnicolid snails found in the basal Tulare formation (of Upper Pliocene age), in the Kettleman Hills oil field of California. The remaining four species were discovered in the lower Pliocene beds of the Laverne formation in Beaver county, Oklahoma (Leonard and Franzen, 1944).

Although the entire series of species is similar with respect to body form, aperture, umbilical perforation, and distribution of spiral striations, giving the group an appropriate homogeneity, there is present among them a considerable degree of variation with regard to such characters as surface sculpture, depth of suture, and contour of whorls. The colorful qualities of this small group of snails, together with the fact that the two series of species were recovered from deposits of somewhat similar geologic age, but geographically separated by hundreds of miles of plains and rugged mountain terrain, lends peculiar interest to the genus. Furthermore, while the unity of this unique group of species appears to us well established, it seems prudent to call to the critical attention of others the various species now assigned to the genus *Calipyrgula*. With these concepts in mind, we present the following annotated list, with figures of each species drawn to the same scale.

GENUS CALIPYRGYLA

Pilsbry, 1934, *Nautilus*, Vol. 48, p. 15.

Pilsbry, 1934a, *Proc. Acad. Nat. Sci. Phila.*, Vol. 86, p. 556.

"Minute, thin, very slender, perforate shells, with rather obtuse apex; of about 5 to 7 whorls which are strongly convex, rounded or carinate, and in known species, spirally striate. The aperture is elliptical or oval, blunt or rounded posteriorly, the peristome thin, columellar margin slightly expanded. Type, *C. carinifera*." (Pilsbry, 1934a).

Calipyrgula carinifera Pilsbry, Plate 1, fig. 4

Pilsbry, 1934, *Nautilus*, Vol. 48, p. 15.

Pilsbry, 1934a, *Proc. Acad. Nat. Sci. Phila.*, Vol. 86, p. 556.

Type. United States National Museum.

Type locality. Kettleman Hills oil field, Sec. 30, Tp. 21 S, R 17 E, Fresno county, California.

Horizon. Basal Tulare formation, Upper Pliocene.

Calipyrgula carinifera Pilsbry, one of the minute species but exceeding slightly in height both *C. ellipsostoma* Pilsbry, and *C. stewartiana* Pilsbry, is characterized by its slender form, strongly convex whorls and deeply incised suture. A carina at the periphery accompanied by fine concentric striations below is typical.

Variations. The characteristic carina and fine concentric striations do not appear on the first two whorls. Of the remaining spiral whorls all are typically carinate and striate, although an occasional smooth and rounded whorl may appear at random among them. Among the specimens available for study,* the body whorl and one or more spiral whorls were characteristically carinate and striate. That specimens with the same number of whorls vary somewhat in size is shown in the table below.

U. S. N. M.	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	3.24mm.	1.1mm.	0.9mm.	0.72mm.	6½
Paratype	2.7	1.08	0.81	0.58	5½
Paratype	2.16	0.81	0.63	0.45	5½
Paratype	2.0	0.85	0.67	0.54	5½

* We are grateful to Dr. Paul Bartsch, Curator of Cenozoic Invertebrates, United States National Museum, and to Dr. Henry A. Pilsbry, Curator of Mollusca, Philadelphia Academy of Natural Science, through whose generosity we were able to examine the specimens of *C. carinifera* and *C. ellipsostoma* from these institutions, including the types. We have not seen the type of *C. stewartiana*.

Calipyrgula ellipsostoma Pilsbry, Plate 1, Fig. 5

Pilsbry, 1934, Nautilus, Vol. 48, p. 15.

Pilsbry, 1934a, Pro. Acad. Nat. Sci. Phil., Vol. 86, p. 557.

Type. No. 12946, Academy Natural Science of Philadelphia.*Type locality.* East side of North Dome, Kettleman Hills, Sec. 23, Tp. 23 S, R 18 E, Kings county, California.*Horizon.* Basal Tulare formation, Upper Pliocene.

Calipyrgula ellipsostoma Pilsbry is similar in form to *C. carinifera*, but is less slender, the suture is less deeply incised, and a feebly developed carina appears above the periphery.

Variations. The only significant variation observed in the small series available to us was in the development of the carina which is obsolete in some examples.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	3.1mm	1.09mm.	0.9mm	0.63mm.	6½
Paratype	2.5	0.99	0.81	0.63	5¾
Paratype	2.25	0.9	0.72	0.63	4½

Calipyrgula stewartiana Pilsbry, Plate 1, Fig. 1

Pilsbry, 1934, Nautilus, Vol. 48, p. 17.

Pilsbry, 1934a, Pro. Acad. Nat. Sci. Phil., Vol. 86, p. 557.

Type. United States National Museum.*Type locality.* East side Middle Dome, Kettleman Hills, Sec. 12, Tp. 23 S, R 19 E, Kings county, California.*Horizon.* Basal Tulare formation, Upper Pliocene.

Calipyrgula stewartiana resembles *C. carinifera* in having the first two whorls smooth and convex, the remaining whorls of the spire carinate at the periphery and spirally striate below; but it differs from *C. carinifera* in the relative obesity of the body whorl.

Variations. The species is known only from the type.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	2.9mm.	1.5mm.	0.95mm.	....	5½

Calipyrgula hibbardi Leonard and Franzen, Plate 1, Fig. 2

Leonard and Franzen, 1944, Univ. Kan. Sci. Bull., Vol. XXX, pp. 19-20.

Type. No. 980, Kansas University Museum of Natural History.*Type locality.* 6½ mi. S, ½ mi. W, Gate, Beaver county, Okla.*Horizon.* Laverne formation, Lower Pliocene.

This species is similar to *Calipyrgula ellipsostoma* Pilsbry but differs from it by its slightly larger size, more strongly convex whorls, with no more than a faint indication of a carina, deeply in-

cised suture, conspicuous vertical striations, more delicately traced spiral lines below the periphery, and more broadly oval aperture. The deeply incised suture and the spiral lines are features which relate *C. hibbardi* to *C. carinifera*.

Variations. Upon individuals having the vertical striations coalesced into relatively strong ridges the spiral lines are concomitantly obscure. The slight variation in the height-diameter ratio is shown in the table of measurements.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	4.1mm.	1.6mm.	1.0mm.	0.6mm.	7
Paratype	4.2	1.6	1.3	0.8	7
Paratype	4.1	1.58	1.1	0.7	7
Paratype	3.9	1.58	1.26	0.8	7
Paratype	3.7	1.5	1.17	0.8	7

Calipyrghula turricula Leonard and Franzen, Plate 1, Fig. 7

Leonard and Franzen, 1944, Univ. Kan. Sci. Bull., Vol. XXX, p. 20.

Type. No. 982, Kansas University Museum of Natural History.

Type locality. 5½ miles S Gate, Beaver county, Oklahoma.

Horizon. Laverne formation, Lower Pliocene.

Calipyrghula turricula has a narrowly conic shell, similar to *C. hibbardi*, but is distinguished from the latter by its larger size, larger number of whorls (maximum of eight) and by its relatively coarse vertical striations. Spiral lines are not prominent in either *C. hibbardi* or *C. turricula* but are distributed below the periphery as in *C. carinifera*.

Variations. The vertical striations vary from fine, evenly-spaced, raised lines to coarser lines approaching riblets: the development of the coarser vertical ridges tends to suppress the expression of the spiral threads. Occasional examples, apparently unworn, have neither well-developed vertical, nor well-defined spiral striations.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	6.6mm.	2.2mm.	2.1mm.	1.1mm.	8
Paratype	6.5	2.5	2.0	1.4	7
Paratype	5.3	2.0	1.6	1.3	7
Paratype	4.8	1.8	1.3	1.2	7

Calipyrghula tumida Leonard and Franzen, Plate 1, Fig. 3

Leonard and Franzen, 1944, Univ. Kan. Sci. Bull., Vol. XXX, p. 20.

Type. No. 984, Kansas University Museum of Natural History.

Type locality. 5½ mi. S Gate, Beaver county, Oklahoma.

Horizon. Laverne formation, Lower Pliocene.

Calipyrgula tumida is similar to *C. turricula* but may be differentiated from the latter by its somewhat lesser height, smaller number of whorls, the obesity of the body whorl, more broadly conic profile and by the relatively larger and more elongate aperture. Spiral lines below the periphery are invariably inconspicuous and sometimes indiscernible.

Variations. There is perhaps a greater size range among individuals with the same number of whorls than is found among other known species of the genus. Vertical striations vary from closely spaced, fine, raised lines to aggregations which form low ridges, especially on the body and the penultimate whorls.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	5.6mm.	3.7mm.	2.1mm.	1.5mm.	6½
Paratype	5.0	2.6	1.8	1.6	6
Paratype	4.5	2.3	1.7	1.2	6
Paratype	4.1	2.2	1.7	1.1	6

Calipyrgula senta Leonard and Franzen, Plate 1, Fig. 6

Leonard and Franzen, 1944, Univ. Kan. Sci. Bull., Vol. XXX, p. 21.

Type. No. 986, Kansas University Museum of Natural History.

Type locality. 6½ mi. S ½ mi. W Gate, Beaver county, Okla.

Horizon. Laverne formation, Lower Pliocene.

The distinguishing feature of *Calipyrgula senta* is a series of widely spaced, heavy, subconical spines, united at their bases by a spiral ridge slightly above the periphery, and paralleled by a second spiral ridge below the periphery. Vertical striations, varying from fine threads to coarse ridges, embellish all the whorls except the first one and a half. Spiral striations other than the two carinae mentioned are obscure or wanting. In general form *C. senta* is intermediate between the narrow, elongate *C. turricula* and the more broadly conic *C. tumida*.

Variations. The spines appear typically on the body and the penultimate whorls, but the series may extend over all the whorls except the first two, or may be limited to the body whorl. Rarely they are absent with only the carina remaining. Frequently the spines are buttressed below or above or both by a ridge parallel to the vertical striations. Occasionally the carina below the periphery is wanting.

	Height	Diameter	Aperture Height	Aperture Diameter	Number of Whorls
Type	4.8mm.	2.2mm.	1.5mm.	1.2mm.	7
Paratype	4.7	2.3	1.6	1.2	6½
Paratype	4.7	2.2	1.6	1.1	6½
Paratype	4.7	2.2	1.6	1.1	6

DISCUSSION

At the time Pilsbry described the three species of snails which he allocated to the genus *Calipyrgula*, the geology of the Kettleman Hills region was imperfectly known; however, on the authority of the geologists who collected the material, Pilsbry referred to these snails as "Pliocene species" (Pilsbry, 1934a, p. 556). The detailed studies of Woodring, Stewart and Richards (1940) have clarified the stratigraphic relations of the Tulare formation to a certain degree, but the nature of the deposits making up this formation, and the unfortunate lack of mammalian fossils makes it difficult to determine the age of the formation with certainty. The absence of discernible disconformities between the Tulare and the overlying Pleistocene and Recent alluvial deposits compelled Woodring and his colleagues to give the Tulare formation the age designation of "Pliocene and Pleistocene (?)". Nevertheless, they state unequivocally (op. cit., p. 104) that the basal Tulare is Upper Pliocene in age.

The lithology of the beds containing the *Calipyrgula* is described in their notes on a measured section, taken on the east side of northern Middle Dome, sec. 17, T. 23 S., R. 19 E., where they state (op. cit., p. 19) "Cross-bedded gray sand, containing oolites and scattered *Amnicola*, *Calipyrgula*, *Valvata*, *Pyrgulopsis*, and *Pisidium* (locality 14) alternating with discontinuous layers of imperfectly cemented brownish-gray sandstone as much as 2 feet thick. Base not exposed." This lower *Amnicola* zone, in which the *Calipyrgula* occur, is considered a freshwater lacustrine deposit, although during the previous San Joaquin time, an extensive arm of the sea reached the Kettleman Hills area. Even during early Tulare times the deposits were apparently laid down in brackish water during brief intervals, but there is no obvious reflection of this in the gastropod fauna of the basal Tulare.

The localities in the Laverne formation from which *Calipyrgula* have been recovered consist of deposits of shale, sandy-silt, interbedded with thin strata containing carbonized material and fossilized wood, and sometimes overlain with cherty limestone. An analysis of the probable ecological conditions points toward a lacustrine environment here, and there is some indication of brackish water existing at times during the formation of the Laverne deposits. Many of the contained diatoms are relatives of living forms restricted to saline or brackish waters (Leonard and Franzen, 1944, p. 31); furthermore, the development of the spinous excrescences on *Calipyrgula senta* is a possible reflection of brackish water condi-

tions (op. cit., p. 33). That the brackish water may have been derived from upward migration of brines from the underlying salt beds of the Permian, as suggested by Frye (*vide* Leonard and Franzen, 1944, p. 34) is an idea to which credence is lent by actual observation in localities not far from the Laverne deposits. In southern Meade county, a few miles north of the type localities of the *Calipyrgula* species, such saline ponds were still in existence until recent floods along the Cimarron river buried them under sand (Hibbard, 1945). Since these ponds were limited in extent, and often lay adjacent to freshwater pools, the conclusion is that the saline pools were rendered so by upward migration of brines from deeper strata containing salt. Regardless of the mechanisms involved, the nature of the deposits and the associated fauna indicate very similar ecological conditions in the Tulare and Laverne formations at the time the snails were living.

The extreme paucity of reported gastropod faunules from Pliocene deposits in North America makes it inadvisable to indulge in conjectures concerning the center of dispersal and migration routes of the species of *Calipyrgula*, except for the obvious observation that the mountain barriers in North America indicate that the center of dispersal must have been as far south as the Mexican plateau. Furthermore, it is equally obvious that the species of the two localities have been separated long enough to have differentiated into two distinctive groups; the one in California tending toward small size and fine sculpturing of the shell, the other in Oklahoma characterized by generally larger size, and coarser shell sculpturing. Since the genus is yet so poorly known, it is not possible to learn whether these group characters are due to environmental influences, or to some inherent genetic qualities.

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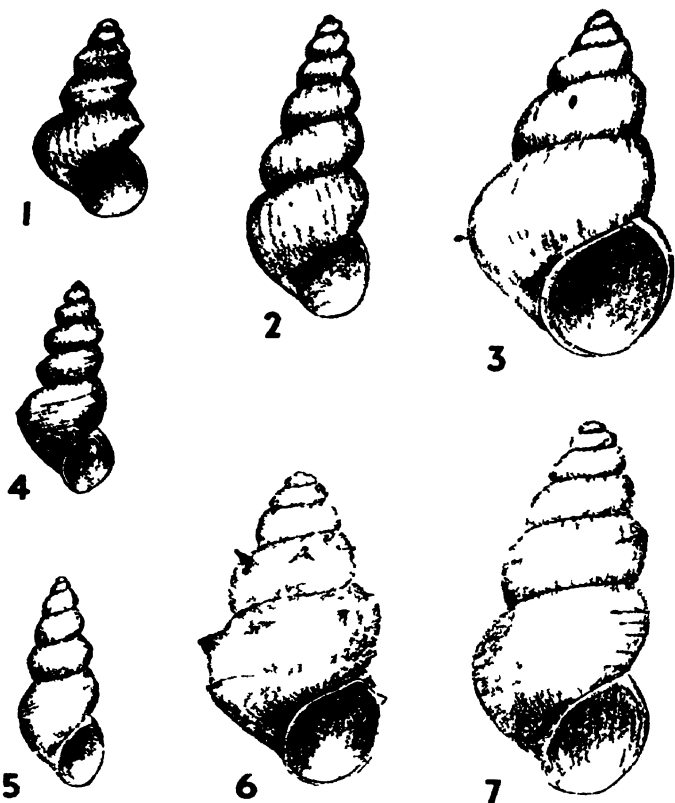


FIG 1 *Calipyrghula stewartiana* Redrawn to scale from Pilsbry, 1934a, Pl 21, fig 2

FIG 2 *C. hubbardi*, type

FIG 3 *C. tumida* type

FIG 4 *C. carmifera*, type

FIG 5 *C. ellipsostoma* type

FIG 6 *C. senta*, type

FIG 7 *C. turricula*, type

(All figures reproduced on scale of $\times 10$)

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[No. 6

Mollusca from Greenwood County, Kansas

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ABSTRACT: Sixteen species of unionid mussels, six species of aquatic gastropods, and nineteen species or subspecies of terrestrial gastropods are reported from Greenwood county, southeastern Kansas. The collecting stations are described, the species listed are briefly annotated, and comparisons are drawn between this fauna and known molluscan faunas from other parts of the state of Kansas.

ALTHOUGH the late R. Ellsworth Call first published on the mollusca of Kansas sixty years ago (Call, 1885) the native living fauna of the state is still but little known. Later published reports include the fresh-water mussels of the state (Scammon, 1906), the gastropods of Douglas county (Hanna, 1909), a preliminary study of the mollusks of Kingman county (Franzen and Leonard, 1942), the mollusks of the Wakarusa river and its valley (Franzen and Leonard, 1943), the mollusks of Clark and Meade counties (Leonard, 1943), and a list of new state records, comprising twelve forms of gastropods (Franzen, 1944). The present report deals with the mollusks in a region of the state not previously studied.*

Greenwood county lies on the eastern slopes of the Flint Hills, and is drained by Fall river, the Verdigris river, and their tributaries. Timber is not abundant on the grass-covered hills, but near streams there are stands of elm, oak, sycamore, maple and hickory, together with dense growths of native shrubs, which, with a moderately adequate supply of moisture, afford suitable habitats for terrestrial gastropods. The prevailing rock outcrops are limestones and shales, which provide a soil rich in the calcium needed by mol-

* We are grateful to Dr. C. W. Hibbard of the Museum of Natural History, Kansas University; to Mr. and Mrs. Charles Hibbard of Toronto; and to Dr. G. C. Rinker and his son Richard, of Hamilton, all of whom assisted in making the collections or otherwise facilitated our work in the county.

lusks, but occasional outcrops of sandstone produce local changes in environment. In general, erinaceous soils are almost devoid of mollusks, but there are certain exceptions, which will be noted below.

In the short time at our disposal, collections were necessarily restricted to a few selected stations.

STATION 1. Near the headwaters of Burnt creek, one mile north, one-half mile west of Reece, S. 6, T. 26 S, R. 8 E, in the western part of the county. Only a scant growth of trees, largely elm, occurs here, but by collecting in debris cast up by high waters, we obtained a rather large number of species at this locality.

STATION 2. Approximately one-fourth mile above the town of Fall River, S. 13, T. 28 S, R. 12 E, on the heavily timbered flood plain of Fall river, and the slightly higher, also timbered, ground above the flood plain. Deep leaf mold, fallen logs, deep shade and good moisture conditions produce an ideal habitat for terrestrial gastropods.

STATION 3. One mile east, two miles north of the town of Fall River, in hardwood timber along Shawnee creek. A good stand of oaks and hickory provided suitable cover. The creek has incised the Ireland sandstone which occurs as eroded blocks along the flanks of the floodplain. Contact springs assist in regulating moisture; mosses and ferns grow abundantly.

STATION 4. The steep rocky slopes along Carlysle creek, approximately nine miles north, two miles east of the town of Fall River, S. 32, T. 26 S, R. 13 E. The rock outcrops are limestone, the slopes of the ravine through which the creek runs are well drained, and bear a fair stand of oak, hickory, elm and sycamore trees.

STATION 5. The grass-covered slope of a treeless hill on the Hibbard farm, S. 5, T. 27 S, R. 13 E, approximately eight miles southwest of Toronto. Seeping springs provide abundant moisture which forms tiny pools in small depressions, such as cattle tracks, among the clumps of bluestem grass.

STATION 6. Shoals and bars of shingle and gravel in West creek, S. 21, T. 24 S, R. 11 E, four miles east, two miles south of Hamilton. Deep pools here are known to be abundantly populated with pelecypods, but since we visited this creek in late October when the water was very cold, collections were limited to shells, largely "dead" ones, found on gravel bars, or in the shallow water of shoals.

STATION 7. An artificial pond eleven miles west of Madison, S. 20, T. 22 S, R. 10 E. This pond is situated in a shallow depression at the foot of gentle slopes leading to the surrounding Flint hills.

No trees or shrubs are found in the near vicinity, but the shores of the pond support a luxuriant growth of grasses and sedges, and plant debris cast up by high water affords additional cover for small gastropods.

STATION 8. The headwaters of one of the tributaries to the Verdigris river, located in the treeless Flint hills, twelve miles west and approximately two and one-half miles south of Madison. Several small creeks rise here from numerous contact springs; since the creeks flow over gravel and shingle derived from limestone outcrops, the water is clear and free from silt. A sparse stand of elm, oak and sycamore trees occurs in the near vicinity of the creeks, but there is very little growth of native shrubbery, or other cover suitable for terrestrial snails. No mollusks were found in these streams, although a small colony of *Lymnaea bulimoides techella* thrived in an ephemeral pool on the flood plain, and two examples of *Physa hawnii* were found on watercress growing in the overflow from a spring. Since ecological conditions in these streams seem ideal for mollusks, the complete absence of both gastropods and pelecypods presents an unsolved problem. Salt water or oil flowing into these creeks from oil wells nearby may have exterminated any mollusks that may have lived in these waters, but at present there is no sign of contamination.

The molluscan fauna of Greenwood county as now known includes sixteen species of unionid mussels, six species of aquatic gastropods, and nineteen species and subspecies of terrestrial gastropods. These are listed below in the form of an annotated checklist; the numbers refer to collecting stations at which the several forms were found.

PELECYPODA

FAMILY UNIONIDAE

All from station 6.

Truncilla truncata (Say). Not common.

Lampsilis anodontoides (Lea). Typical forms; not abundant.

Lampsilis siliquioidea (Barnes). The most common *Lampsilis*; the shells tend to be unusually heavy, sometimes malformed.

Lampsilis ventricosa (Barnes). Least common *Lampsilis*; shells very inflated and heavy.

Ligumia subrostrata (Say). Common; typical.

Proptera cf. *purpurata* (Lamarck). Common; shell characters make it difficult to assign these forms to a species with certainty,

but in our opinion, these forms are closer to typical *P. purpurata* than to *P. alata*.

Leptodea fragilis (Swanson). Fairly common; shells unusually heavy for this species.

Tritogonia verrucosa (Say). Not numerous; typical.

Anodonta grandis (Say). Not numerous; shells smaller and less inflated than typical forms.

Lasmigona complanta (Barnes). Found abundantly; typical.

Unio merus tetralasmus (Say). Not common; typical.

Amblema costata (Rafinesque). Numerous; development of ridges not typical, tending toward *A. peruviana*, but other characters typical of the species.

Quadrula quadrula (Rafinesque). Common; shells gigantic for the species.

Quadrula pustulosa (Lea). Common; pustules very poorly developed or absent.

Fusconaia flava (Conrad). Common; shells unusually large for the species.

Obliquaria reflexa (Rafinesque). Rare; this species is never found in numbers in Kansas streams.

AQUATIC GASTROPODA

FAMILY LYMNAEIDAE

Lymnaea bulimoides techella (Haldeman): 1, 4, 5, 7, 8. Although found breeding in pools, this form is seldom found in permanent water. It burrows beneath the mud during dry seasons.

Lymnaea humilis rustica (Lea): 4.

Lymnaea parva (Lea): 5. These two forms are small, and seem to prefer mud near water, rather than actual submergence.

FAMILY PLANORBIDAE

Helisoma antrosa (Conrad) (-anceps): 1, 4. Less common than *H. trivolvis*, apparently because of a closer restriction to habitat. It prefers clean running water.

Helisoma trivolvis (Say): 1, 4. Common in streams and ponds.

FAMILY PHYSIDAE

Physa hawnii Lea: 1, 2, 4, 7, 8. Common everywhere in streams and ponds.

TERRESTRIAL GASTROPODA

FAMILY POLYGYRIDAE

Triodopsis albolabris alleni (Sampson); 2. Confined to timbered areas, where good moisture conditions prevail.

Mesodon thyroidus (Say): 2. Never common in Kansas, and confined to heavily wooded areas.

Stenotrema monodon aliciae (Pilsbry): 2, 3, 7. These forms present taxonomic difficulties; further elucidation of the *fraterna-monodon* complex in Kansas is needed.

FAMILY BULIMULIDAE

Bulimulus dealbatus (Say): 1, 2, 7. These large snails prefer to live on rocky slopes, but are frequently found living in drifts of plant material. Numerous at no. 7.

FAMILY ZONITIDAE

Retinella electrina (Gould): 3. Not common; found in leaf mold and under decaying logs.

Retinella indentata (Say): 1, 2, 3, 4, 5. More numerous than *R. electrina*; habitat similar.

Hawailia miniscula (Binney): 1, 5, 7. Never numerous, but widely distributed in Kansas; prefers open grassland, but occurs in woodlands as well.

Euconulus chersinus cf. *polygyratus* Pilsbry: 1, 3. A woodland species.

Zonitoides arboreus (Say): 1, 3, 4, 5. Common and numerous in woodlands; it thrives also in open grasslands.

FAMILY ENTODONTIDAE

Anguispira alternata alternata (Say): 2, 3, 4. Common in wooded areas. At No. 2 these snails were so numerous on the flood plain of Fall River that it was literally impossible to walk without crushing their shells at every step. At No. 3, where sandstone rocks outcrop strongly, the high-spined form of *A. alternata*, to which the subspecies name *eriensis* has been applied, occurs with the typical form. Since the two forms occur together, we regard the name *eriensis* as invalid, and consider the high-spined form of shell a phenotypic variant, produced in some way by the sandy substrate.

Helicodiscus parallelus (Say): 1, 3, 7. Never numerous; found near decaying stumps and in rock ledges.

FAMILY PUPILLIDAE

Gastrocopta armifera abbreviata (Sterki): 1, 2, 3, 4, 5, 7. These tiny snails are abundant in woodlands in leaf mold; they also occur in open grasslands.

Gastrocopta contracta (Say): 1, 3. Only a few examples of these tiny snails were found; it is probably more common than realized.

Gastrocopta procera sterkiana (Pilsbry): 1, 4.

Gastrocopta procera mcclungi (Hanna and Johnston): 1, 4. As far as known, both these forms are typically western in distribution in Kansas; only a few examples of each were found, and these from plant drift.

Pupoides marginatus (Say): 1, 3, 7. Found both in woodlands and open grasslands; widely distributed in Kansas and elsewhere.

FAMILY STROBILOPSIDAE

Strobilops labyrinthica parietalis Pilsbry: 3, 4. These snails, though minute, have exquisitely sculptured shells. Restricted to woodlands.

FAMILY VALLONIDAE

Vallonia costata (Müller): 1. A few shells recovered from drift are assigned to this species; the Kansas vallonias have never been adequately studied.

FAMILY SUCCINEIDAE

Succinia avara Say: 1, 2, 4, 5, 7. Found along streams in grass and sedges; not strictly aquatic.

DISCUSSION

Although Greenwood county lies approximately 100 miles southwest of Douglas county, the general character of the molluscan fauna is not unlike that of Douglas county as reported by Hanna (1909). While our list of species is less extensive than Hanna's, it is worthy of note that every form we list here is also known from Douglas county. A few genera reported by Hanna have not been found in Greenwood county. *Pupilla* probably does not occur in the Greenwood county fauna, nor have we found it resident in Douglas county; Hanna's specimens came from Kansas river drift, and were very likely Pleistocene fossils, since *P. muscorum* is abundantly represented in Smoky Hill river deposits. On the other

hand, some species of *Vertigo* very probably is native to Greenwood county, but we failed to find examples. We found a species of *Amnicola* near No. 6, represented by shells found under conditions which make it appear that the species is extinct there. *Campeloma* may yet be found in Fall river; at the time we were collecting in the county, Fall river was near flood stage, and we did not find examples of the genus elsewhere. We did not find *Hendersonia occulta* (Say), but this species is notorious for its erratic, local distribution; a living colony has yet to be found in the state, though fossils are common in some Pleistocene deposits.

As far as can be ascertained from our studies, the relative abundance of the several species found in Greenwood county is not unlike that in Douglas county, with the exception of *Bulimulus dealbatus*, which is locally abundant in Greenwood county. This species, which is typically southern in its distribution, ranges from North Carolina to Texas. The greater abundance of the species in Greenwood county is thus the only evidence of the influence of a more southerly position in the state. However, such genera as *Goniobasis*, *Haplotrema*, *Mesomphix*, and *Polygyra*, which occur in the eastern and southern portions of Kansas are apparently missing from the Greenwood county fauna, although local conditions would seem not inimical to them, and the drainage pattern lends itself to migration in the direction of Greenwood county. In spite of the obvious fact that Kansas is a meeting-ground for both eastern and western, and southern and northern, species of mollusks, particularly gastropods, the data thus far accumulated indicate that the molluscan fauna of the state is much more conspicuously stratified in an east-west manner, than in a north-south manner. This is, of course, a reflection of the zonation within the state with reference to soil, rainfall and flora, all of which may be zoned more readily in an east-west direction than in a north-south direction. It is scarcely necessary to point out that the three factors mentioned are of prime importance in the distribution, not only of mollusks, but of all animals.

The list of pelecypods, represented only from the collections made in West creek, gives a very incomplete picture of the freshwater mussel population, not only because the list was compiled from a single collection, but because it is a creek fauna. River faunas are generally more varied; furthermore, certain forms are restricted to larger streams. It has been our fortune to find Fall

river near flood stage each time we have been in the vicinity, making collecting in the stream quite impossible. When circumstances lend themselves to work in Fall river, the pelecypod fauna of the county will become more accurately known.

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Description of a Presomite Human Embryo

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ABSTRACT: The anatomy of a presomite human embryo of an estimated age of less than three weeks is described and figured by drawings and photomicrographs.

INTRODUCTION

THE first careful and detailed description of a human embryo was made by Jones in 1837. Since that time many human embryos were discovered, described, and made available for study. Since these embryos were obtained under unusual circumstances, by abortions, curettings, and operations, many of them were damaged, either in the process of obtaining them, or injured by post operative handling. Within the past twenty years, more human presomite embryos were described than in the entire preceding century. Our knowledge of human embryology has increased considerably over a period of years, for which we are indebted to many investigators and collectors, notably Grosser, Stieve, Florian, Fetzner, Teacher, and Bryce in Europe, and Hill, Streeter, Ingalls, Heuser, and Brewer in the United States.

Although a great deal of advancement has been made in human presomite embryology, there are many problems concerning development which can be solved by further study of additional embryos. Human embryology has arrived at a stage where duplication of ages is frequent, still, no two embryos show exactly the same degree of development. While embryos of the same age add nothing new to our knowledge of human embryology, they do, nevertheless, play an important part in substantiating observations made by investigators in previously described human embryos. The embryo on which this study was made, while contributing nothing new, corroborates the findings of earlier investigators.

CASE HISTORY

Unfortunately, the clinical history of this specimen is very meager. Additional clinical data would have made this study much more interesting, but, in this instance, more information could not be obtained because the physician failed to coöperate. This embryo was obtained through the coöperation of Mr. Robert W. Meyers, medical student, The University of Kansas, who obtained the specimen and presented it to the senior author. The label on the vial containing the embryo bore the following legend: "Ovum removed from uterus after hysterectomy. Patient 7 to 10 days past 'due.'" The comparison of this embryo with the Mateer, Ingalls and Brewer embryos, as well as a comparison with limited macaque material of known ages, has fairly well established its age. The elapsed time between the removal of the ovum and its fixation is not known. This interval must have been very short since the extra-embryonic structures are well preserved.

TECHNIQUE

The blastocyst was washed in several changes of distilled water, dehydrated for one hour in each of a series of alcohols ranging from 5 to 95 percent. It was further dehydrated in two changes of absolute alcohol, remaining in each alcohol for one hour. A slow process of clearing was also observed. The blastocyst was placed into a mixture of two-thirds absolute alcohol and one-third xylol, then into a mixture of one-third alcohol and two-thirds xylol and finally cleared in xylol. It remained in each of these solutions for one hour. The specimen was next infiltrated with paraffin for one hour, a change of paraffin having been made at the half time period. During the process of infiltration, the dorsal surface of the chorion collapsed slightly, giving it an elliptical appearance in section. The blastocyst was blocked carefully, sectioned at ten micra, and the sections were mounted on the slides. Whenever possible, two rows of sections were mounted on the slides. A total of 91 slides, containing both the chorion and the embryonic rudiment, was obtained. Because of incomplete infiltration, it was found necessary to reblock the vesicle. A few sections of the chorionic vesicle were necessarily lost in reblocking the specimen. In the process of staining and mounting, two sections of the embryo were lost. The sections were stained with haematoxylin-eosin and mounted in balsam. Seven slides of the chorion were refixed in Zenker-formol and stained with Mallory triple connective tissue stain.

METHODS OF STUDY

An approach to the study of this embryo was made by the study of the slides, by the construction, by the wax plate method, of a three dimensional model of the embryonic disc with the entodermal roof of the yolk sac, by a graphic reconstruction of the embryonic disc and its allied structures, and by the photographing of representative sections.

The model of the embryonic disc, together with the entodermal roof of the yolk sac, was made in the following manner: the length of section 60.1 was measured with a calibrated ocular micrometer and the figure obtained was calculated to a magnification of 200 diameters. Section 60.1 (not figured) was projected through a microprojector on a white sheet of paper at a magnification of 200 diameters. After the magnification was determined, each section of the embryo was projected and the outline was traced. These outlines were traced with carbon paper onto a large sheet of blotting paper. Three sheets of blotting paper were necessary to give the proper thickness for a magnification of 200 diameters. These were placed in hot paraffin and pressed tightly together. After cooling, the sections were cut out, placed together in their serial order, and stapled together. After all sections of the embryo were cut out and stapled together, a three dimensional model of the embryonic disc and the roof of the yolk sac was obtained. The amnion and yolk sac were cut a short distance above and below the disc, respectively.

The graphic reconstruction of the embryonic disc and its allied parts was made by drawing the outline of each section with a camera lucida at a magnification of 200 diameters. The shield, mesoderm and entoderm were drawn with blue, red and yellow colors, respectively. The length of each section, the distance of the structures from the caudal end, and the lengths of the structures, were measured with a calibrated ocular micrometer. The measurements thus obtained were magnified to 200 diameters and were plotted on graph paper, each small square representing one millimeter. Vertical lines on the graph paper represented the plane of section. By measuring the distance of each structure from the caudal end, and the length of each structure in each section in which it appeared, it was possible to determine the length and width of these structures and their relationships on the completed two-dimensional reconstruction. In this way, Hensen's node, head process and prochordal plate were located and reproduced graphically. Similarly, the

course of the primitive streak and the plane of section were ascertained. A straight line through the primitive streak forms a 34 degree angle with the medial plane of section. Measurements of all structures were taken from this reconstructed graph.

The embryo was studied also from photographs of representative sections. As would be expected, greater detail is seen through the microscope than it is possible to see in a photograph. Descriptions pertaining to the photographs were made from the sections as observed through the microscope.

In the course of study, this embryo was compared with the Ingalls and Mateer embryos. Where it was thought expedient, a comparison of structures in our embryo was made with corresponding structures in the H. R. 1, Falkiner, Dobbin, Manchester, and Heuser embryos.

DESCRIPTION OF EMBRYO AND CHORION

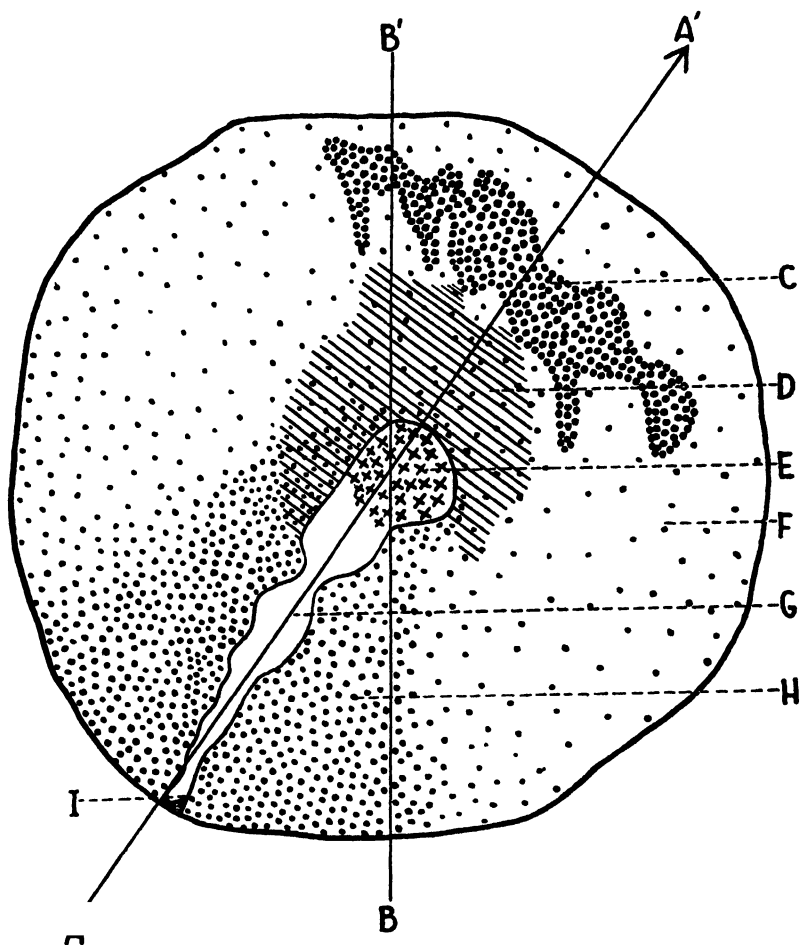
A presomite human embryo consists of a germinal disc, a dorsal amniotic vesicle, a ventral yolk sac vesicle, and a body stalk. The ectodermal cells of the germinal disc thin out abruptly and turn upward where they connect with the ectodermal cells of the amnion. Below, the entoderm of the disc turns ventrad where it connects with the entodermal lining of the yolk sac. Mesoderm covers both the amnion and yolk sac; it is continuous with the mesoderm which lies between the ectodermal cells of the disc and the entodermal roof of the yolk sac. At its caudal end, the embryo is attached to the chorion by a broad mass of mesodermal cells.

Further differentiation in the embryo gives rise to axial structures. On the surface of the disc, an ectodermal thickening forms the primitive streak which terminates near the center in an elevation, known as Hensen's node. A forward growth from Hensen's node, below the disc, is known as the head process. Anterior to the head process, at the cephalic margin of the disc, the prochordal plate arises as an entodermal thickening. Posterior to the primitive streak, the fusion of ectoderm with entoderm gives rise to the primordium of the cloacal membrane. Caudal to the cloacal membrane, an evagination of the yolk sac into the body stalk forms the allantois.

THE EMBRYONIC DISC

In outline, the germinal disc is circular; it is slightly flattened in the cephalic region and moderately convex posteriorly, except in the caudal extremity where there is an acute ventral flexion. The disc

is found in 77 sections. On its long axis, the greatest diameter is 0.82 mm., and its transverse diameter is 0.80 mm. The actual diameter is greater than 0.82 mm., since an error was unavoidably encountered in measuring the sections in the region of the acute ventral flexion. The generally regular contour of the disc is character-



TEXT FIGURE 1. Graphic reconstruction of embryonic disc.

- A-A'. Longitudinal axis.
- B-B'. Plane of section.
- C. Protochordal plate.
- D. Head process.
- E. Hensen's node.
- F. Lateral (loose) mesoderm.
- G. Primitive streak.
- H. Compact mesoderm.
- I. Cloacal membrane.

ized by a series of slight elevations and depressions. Vertical clefts also are observed in the disc. A careful examination of the sections and the model revealed no elevations of the disc which might be interpreted as neural folds.

The disc is composed of tall columnar cells, in one, two or even more overlapping layers, with the nuclei placed at different levels within the cells. These nuclei are either oval or elongated. It is impossible to determine whether or not the difference in the shape of the nuclei is due to the plane of section. The entire embryonic disc is strongly basophilic; the cytoplasm as well as the nuclei take the basic stain. On account of this overstaining, it is difficult to interpret intracellular structures. In various areas, nuclei appear hazy, granular, or even display extensive fragmentation. Under these conditions neither nucleoli nor mitotic figures could be observed or studied with any degree of certainty. This does not, however, preclude the possibility that neither of these structures is present. Numerous intracellular vacuoles of different sizes were observed in the cells of the disc. They are localized chiefly in the anterior third of the disc, and are conspicuously concentrated in an area encircling the node, as well as within the node itself. In some sections, the columnar cells were cut at an angle in such a way as to appear polygonal. No evidence of the yolk sac is found in the first three sections, indicating that the germinal disc moderately overlaps the yolk sac; the yolk sac is detached from the embryo in the caudal region. Along the entire edge of the disc, there is an upwardly curved rim of ectoderm which forms the inner lining of the amnion. The anterior margin of the disc thins out abruptly into a single layer of cells while the corresponding posterior margin is several cells in thickness. This curving of the disc to form the amnion illustrates a gradual transition from the columnar cells to the characteristic spindle-shaped cells of the amnion.

The embryonic disc rests upon a thin noncellular membrane. It is prominent and distinct in the anterior region; it becomes less distinct posteriorly. Moreover, this basement membrane is found throughout the disc except in the region of the primitive streak and Hensen's node. Mesodermal strands one cell thick are attached as loops at intervals to the floor of the disc. In a few of the first sections, the ectodermal cells fuse with the intraembryonic mesoderm. A similar fusion of ectoderm occurs in the area of the prochordal plate, except that in this case, the fusion is with entodermal cells.

PRIMITIVE STREAK AND HENSEN'S NODE

The primitive streak originates in the caudal region of the embryonic disc, courses in an irregular manner anteriorly to terminate a short distance in front of the center of the disc in an enlarged elevation, known as Hensen's node. The length of the primitive streak together with the node is 0.5 mm. The primitive streak is observed in 33 sections. Due to the plane of section, it is possible to observe the node and the lateral margin of the primitive streak in the same section. Hensen's node lies slightly to the right of the long axis of the embryo.

The primitive streak is very narrow at the caudal end of the embryo; it becomes increasingly wider as it approaches its terminus, Hensen's node. Throughout, it is shallow except in the middle third of the disc where it becomes a V-shaped groove. In section, the primitive streak is observed as an area where all three germ layers are indistinguishably fused. In section 62.7, the primitive streak is observed as a cone penetrating the germinal disc. Mesoderm has proliferated laterally from its base. In later sections, the primitive streak appears at the caudal extremity of the disc. This retrogression of the primitive streak in successive sections indicates that the streak was sectioned at an angle.

The superficial cells of Hensen's node are low columnar, and they stain faintly in most sections. Extensive vacuolization of these cells is characteristic for the node and the immediate surrounding area. Hensen's node has actively proliferated cells forward, between the embryonic disc and the roof of the yolk sac; this proliferation from the node has been identified as the head process.

THE HEAD PROCESS

An area of undifferentiated, compact cells arising from Hensen's node and growing cephalad between the germinal disc and the yolk sac, has been identified as the head process. It is 0.27 mm. long and 0.23 mm. wide. The broad caudal part of the head process extends posteriorly around Hensen's node. The head process is observed from section 60.4 to section 63.2. In the graphic reconstruction, it is skewed to the left of the median axis. The head process merges with mesoderm laterally, receives mesoderm from the primitive streak posteriorly, and is continuous with the prochordal plate anteriorly. Entodermal cells are indistinguishable in the region of the head process. Several desquamated entodermal cells, however, are

observed to lie freely in the yolk sac below the head process. The head process is composed of two types of cells, undifferentiated round cells with round nuclei, and columnar cells with elongated nuclei. The former type predominates. Columnar cells, varying from 6 to 20 in number, were observed from section 61.11 to 62.5, below the basement membrane, on the anterior slope of Hensen's node.

THE PROCHORDAL PLATE

The prochordal plate is an entodermal thickening in the head region which in some lower forms gives rise to the premandibular somites, proliferates head mesenchyme, and contributes to the formation of the oral plate.

In this specimen, the prochordal plate is a crescentic area of thickened entoderm situated anterior to the head process and terminating near the cephalic margin of the disc. The plate was traced serially from section 58.12 to section 62.7. It has reached its greatest development in slides 61.1 and 61.2, where it is composed of typical entodermal cells, that is, large, round cells with a relatively small cytoplasm and with large round nuclei. Under high magnification, cytoplasmic strands, characteristic of mesodermal cells may be observed winding in and about these entodermal cells. Since the margins of the prochordal plate thin out gradually, it is impossible to differentiate between this structure and the mesoderm with which it is continuous. Its broad lateral extension indicates that it was actively proliferating mesoderm. Chromatophilic granules, sometimes found associated with the prochordal plate, were not observed. A slight overstaining of this structure may have obscured these granules so that they could not be identified. A fusion of the ectoderm of the germinal disc with the entodermal cells of the prochordal plate was observed.

THE AMNION

Since the embryo lies on the opposite side of the chorionic cavity from its original attachment (Fig. 1, plate IV) the caudal portion of the amnion is separated from the embryo and remains attached to the body stalk.

Along the lateral margins of the disc, the amnion is composed of a layer 6 to 8 cells in thickness; in the central region, it thins out to two layers of cells. The amnion is collapsed upon the germinal disc, thus, the amniotic cavity is practically obliterated. An acidophilic cellular detritus punctuated sparingly with basophilic

granules and spherules was observed along the peripheral margin of the amnion.

The amnion of this specimen is characteristic of embryos in this stage of development. It is composed of an inner layer of cells originating from the ectodermal disc, and, of an outer layer of mesodermal cells. The former is continuous with the ectodermal disc, while the latter is continuous with the intraembryonic mesoderm. The ectodermal layer of the disc gradually transforms from tall columnar cells, to short columnar cells, rounded and fusiform cells, respectively. The outer mesodermal layer is composed of either rounded or spindle-shaped cells, the latter type predominating. Both of these layers, as a rule, are fused together, and occasionally some matrix is found between the two. Shrinkage spaces between these two layers of the amnion are common.

The amnion in the region of the body stalk becomes smaller until it is supplanted by a heavy infiltration of extraembryonic mesoderm. The two layers of cells of the amnion in the region of the body stalk and the inclosed cellular detritus are identical with the cell layers and detritus found in that portion of the amnion attached to the embryo. The amnion is smaller than the yolk sac.

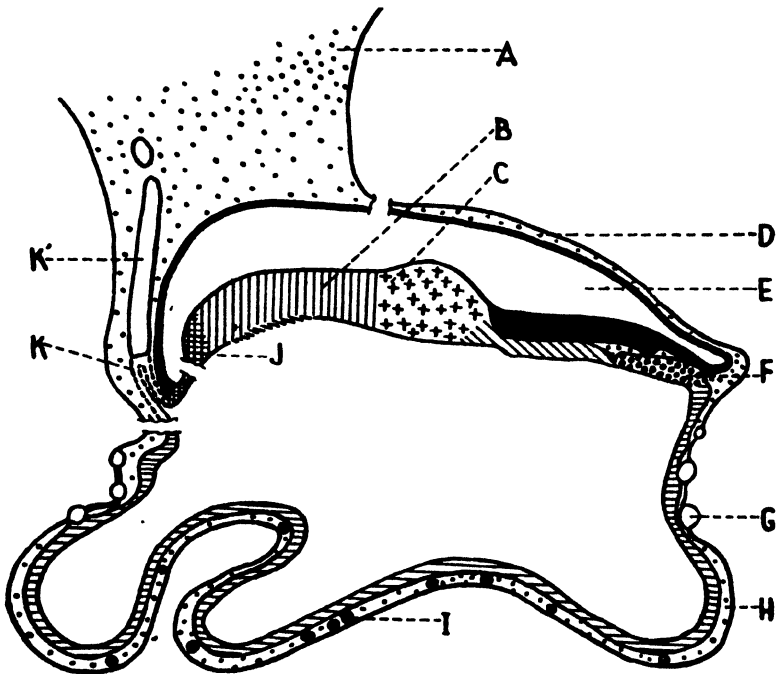
THE YOLK SAC

After separating from the body stalk, the embryo in its path to the opposite side of the chorion, drifted forward moderately; it rests upon the collapsed and folded yolk sac which is enmeshed in an acidophilic granular coagulum. Since the embryo drifted forward, the yolk sac trails behind the embryo for a considerable distance.

As interpreted from sections, the yolk sac is a vesicle lying beneath the germ disc. In succeeding sections, an isolated part of the yolk sac is observed anterior and ventral to the embryo proper. Eventually, these two vesicles become continuous to form the main body of the yolk sac. Posterior to the embryo, the yolk sac again appears as two separate vesicles, one of which is longer than the other.

The yolk sac is composed of two layers of cells, an inner entodermal layer and an outer mesodermal layer. The entodermal cells are typically large, round cells with a relatively small amount of cytoplasm and with large, round nuclei. The cell boundaries may or may not be distinct. The mesodermal covering is continuous with the intraembryonic mesoderm. Although the mesodermal

cells may be either spindle-shaped or round, the former type predominates. As the yolk sac extends ventrally, the lateral and ventral walls become thicker; this additional thickness is due to an eosin-staining fibrillar matrix which is present between the entodermal and mesodermal layers. Mesodermal thickenings of various shapes and sizes, not particularly restricted to any one region, may be found in the lateral and ventral walls of the yolk sac. In section, they appear triangular, paddle-shaped or even as a solid ball of cells. The number of cells entering into the formation of these thickenings varies from 4 to 30, depending upon the stage of development. These thickened areas of mesoderm represent various stages of angiogenesis. In slide 62.8, several mesodermal cysts are observed in the



TEXT FIGURE 2. Idealized median section.

- A. Body stalk.
- B. Primitive streak.
- C. Hensen's node.
- D. Amnion.
- E. Amniotic cavity.
- F. Protochordal plate.
- G. Mesodermal cyst.
- H. Yolk sac.
- I. Blood vessel.
- J. Cloacal membrane (partially reconstructed).
- K. Allantois (reconstructed).
- K'. Allantois.

anterior wall of the yolk sac; these become increasingly larger as they approach the ventral pole. In some embryos, columnar cells have been observed in the yolk sac. A careful search revealed only 6 columnar cells in the entodermal lining of the ventral wall in section 66.5. A scant amount of eosin-staining coagulum, similar to the coagulum found in the chorionic cavity, is found within the yolk sac. Neither entodermal cysts nor septa were observed. Under the circumstances, it is impossible to determine whether or not the yolk sac, in its original position, was attached by mesodermal strands to the opposite side of the chorion. Several mitotic figures, in late telophase, were observed within the yolk sac cells.

THE BODY STALK

The body stalk of this embryo is a solid, funnel-shaped mass of mesodermal cells, attached by its broad end to the chorion. A part of the amnion, separated from the caudal end of the embryo proper, is attached to the anterior part of the body stalk. In section, the amnion lies free near the chorion in the extraembryonic coelom. In succeeding sections, it becomes elongated and is attached at its broad, posterior margin to the chorionic mesoderm. A heavy infiltration of mesoderm cells in the posterior region of the amnion obliterates the cavity and it becomes continuous with the body stalk.

The body stalk is composed of several types of cells enmeshed between an acidophilic matrix. The cells are spindle-shaped, round, oval, and stellate, while the nuclei of these cells are either round, oval, or even angular.

The body stalk is attached to the chorion by an interweaving of the spindle-shaped cells of the chorion with the cells of the body stalk. The chorionic mesoderm has contributed actively to the formation of the body stalk, since these spindle-shaped cells may be observed intermingled among the round and stellate cells which constitute the greater part of the body stalk.

A part of the cloacal membrane, separated from the embryo proper has been observed to be attached to the ventral portion of the amnion. A solid core of cells within the body stalk has been identified as the allantois. Both the allantois and the cloacal membrane will be discussed in a later paragraph.

CLOACAL MEMBRANE AND ALLANTOIS

The original relationships of the cloacal membrane and the allantois have been lost with the separation of the embryo from its body stalk. The cloacal membrane, however, may be observed in

three distinct parts: (1) In its original position in the embryo proper, (2) in the body stalk, and (3) in the detached yolk sac. The distal end of the allantois is seen in the body stalk only.

The separated parts of the cloacal membrane are recognized by the proximity of the detached yolk sac to the region of the cloacal membrane of the embryo proper, and by the similarity of cells in the body stalk to the cells of the cloacal membrane in the embryo proper. In section 64.4, the cloacal membrane is recognized as the fusion of the ectodermal cells of the disc with the entoderm cells of the yolk sac. In this same section, the anterior part of the detached yolk sac, forms the caudal limit of the cloacal membrane, while the detached middle portion is found attached to the amnion in section 63.1.

A solid core of cells projecting half way into the body stalk is the distal part of the allantois. In section 63.8, it is observed as a small cord, enlarged in the following section, and, as two separate structures in section 63.11. These two parts are not connected.

The allantois is composed of closely packed round cells with round or oval nuclei and distinct cytoplasm.

MESODERM

Mesoderm may be classified in several ways. A convenient method is to divide the mesoderm into intraembryonic mesoderm and extraembryonic mesoderm. Intraembryonic mesoderm includes all mesoderm between the ectodermal disc and the roof of the yolk sac, whether it has originated as primitive mesoderm or primitive streak mesoderm. Extraembryonic mesoderm, consequently, form the covering of the amnion and yolk sac, lines the chorion, and forms the inner core of the villi and constitutes the bulk of the body stalk.

The intraembryonic mesoderm of this embryo is a continuous open meshwork of cells except in the median plane, between the head process and the prochordal plate. Where the limits between the ectodermal shield and the entoderm of the yolk sac are narrow, this space may be completely filled with mesoderm. In most sections, the mesoderm is attached by its processes directly to the basement membrane, or when it is absent, attachment is directly to the ectodermal plate above, and to the entodermal roof of the yolk sac, below. Looping strands of mesoderm are more numerous in the caudal region than in the cephalic region. Infrequently, the cells collect into a cluster to form a rosette pattern. The meso-

dermal cells form compact sheets lateral to the primitive streak. In this region, the entoderm is often indistinguishable and is intermingled with the mesodermal cells. On the caudal and cephalic margins where the mesoderm becomes continuous with the amniotic and yolk sac mesoderm, there is a tendency for the mesodermal cells, and probably too, some entodermal cells, to form into small masses or clumps. The cells of the intraembryonic mesoderm are of two types; large, round cells with large, spherical nuclei and with short cytoplasmic processes; and stellate cells with spherical or oval nuclei, and with very fine and exceptionally long cytoplasmic processes. The processes of both types of cells anastomose, and, in addition, are attached to the ventral surface of the disc and/or to the entoderm or the yolk to form a fine open meshwork.

The extraembryonic mesoderm of the amnion is composed of a single strand of continuous cytoplasm, studded with prominent, bulging, elongated nuclei. At the junction of the amniotic mesoderm with the yolk sac mesoderm, there is, very often, a concentration of mesodermal cells, it is impossible to distinguish between intraembryonic mesoderm and extraembryonic mesoderm in this region. The closely attached mesodermal cells following the up-turned rim of the ectoderm have a tendency to be of the round rather than of the fusiform type so characteristic of the amnion. In areas where the amnion is several cells in thickness, the additional thickness is due entirely to the increase of ectodermal cells, rather than to an increase in the mesodermal cells. Both the mesodermal and ectodermal cells are fusiform in the thinned out portion of the amnion.

In the caudal and cephalic regions of the yolk sac where the mesoderm becomes continuous with intraembryonic mesoderm, the cells are typically round, and, as they approach the lateral walls of the yolk sac, are gradually transformed into characteristic fusiform cells. These fusiform cells are again transformed into large, round cells with indistinct cytoplasm in areas which give rise to blood islands.

The mesoderm of the body stalk has been described in an earlier section. The entire body stalk is composed of mesoderm from two sources, the mesoderm from the amniotic covering, and from the inner lining of the chorion. These cells are of two types; from the chorion are given off wavy, spindle-shaped cells with elongated nuclei, but the bulk of the body stalk is composed of large, round cells with nuclei of various shapes and sizes.

Chorionic mesoderm lines the entire cavity of the chorion and evaginates with the cytotrophoblast and plasmoditrophoblast to form the inner core of the villi. These cells abut against the trophoderm in rows, 2 to 3 cells deep with their long axes parallel to it. Where the trophoderm evaginates to form a villus, the strands of chorionic mesoderm increase in number, and become more loose and wavy. Within the villus, they thin out and develop cytoplasmic processes which give rise to angioblastic strands.

• ANGIOGENESIS

Streeter, in describing angiogenesis in the Mateer embryo (1920) concluded that blood vessels were formed in two different ways: (1) In the chorion and villi, angioblastic processes of cells condense to form vessels, and (2) in the body stalk and yolk sac, the blood vessels are formed by mesodermal thickenings without the processes.

In the chorion and villi, angioblastic processes of adjacent cells condense and arrange themselves to form a circular or elliptical contour. These strands enlarge, become swollen and form intracellular vacuoles which later coalesce to form a continuous tube. This swollen mass disrupts, and its contents flow into the lumen. The liquid is plasma and the liberated cells are red blood cells. The intact outer margin of the vessels becomes endothelial in character and forms the blood vessel.

In the yolk sac and body stalk, however, blood vessels are formed by the anastomosis of mesodermal cysts (Fig. 7, Plate VI) or swollen angioblastic strands without cytoplasmic processes. These masses also form vacuoles containing liquid, and, after the wall disrupts, the contents of the masses are liberated into the lumen. Further differentiation is similar to angiogenesis in the chorion and villi.

In the villi of our specimen, all stages of development may be observed from the formation of angioblastic strands to the completed endothelial tubes. Development has reached a higher level in the older and longer villi than in the shorter and younger villi which have thinner endothelial tubes. Within these endothelial tubes, no inclusions were observed which may be interpreted as blood cells. While the development of blood vessels in the villi is primarily by the anastomosis of angioblastic strands, only a few vacuolated strands of doubtful interpretation were observed.

In the posterior wall of the body stalk, the blood vessels have reached the highest stage of development from the standpoint of

their length, thickened endothelium and included blood cells. In section 63.2 several endothelial tubes may be seen both in cross section and in longitudinal sections. When traced serially, these tubes anastomose, and one vessel in the posterior part of the body stalk approaches the trophoderm. A few round cells and some coagulum may be observed in some of these vessels; these are undoubtedly blood cells and blood plasma. These vessels are formed by the anastomosis of angioblastic strands; vacuolization within these cells, if present, could not be observed.

In the yolk sac, all stages of blood vessel formation from the simplest monovacuolated cell to the completed endothelial tube filled with red blood cells may be observed. The older strands are very thick and filled with vacuolated cells, some of which have broken down to form a liquid or a mesh of fine strands. In the ventral region of the yolk sac, in section 64.12, a large endothelial tube composed of about 12 endothelial cells incloses 18 large red blood cells. This is the most highly developed blood vessel in the embryo.

BLASTOCYST AND CHORION

The blastocyst was fixed in ten percent formaldehyde. It was slightly flattened on its resting side and measured 15 x 10 x 5 mm. The blastocyst was soft, spongelike, and light straw color. Under low power, narrow channels contained pinkish material, probably maternal blood, were observed over the surface.

The chorionic vesicle is an externally trabeculated shell which completely envelops the ovum. Generally, the inner lining is spoken of as a membrane, while the outer margin is considered as an incrustation. The inner chorionic membrane is composed of 2 layers of cells; (1) an inner cytotrophoblastic layer, and (2) an outer plasmoditrophoblastic layer. Both of these layers are ectodermal in origin. Mesoderm is closely applied to the cytotrophoblastic layer. Villi are formed as evaginations of the cytotrophoblast and plasmoditrophoblast together with the chorionic mesoderm. As the villi grow, the cytotrophoblast remains unchanged, while the plasmoditrophoblast becomes syncytial in character, precedes the cytotrophoblast and wanders among the maternal tissues. The evaginated mesoderm forms the core of the villi and its branches. Where the villi are most numerous a fusion of the syncytial cells takes place to form the outer incrustation of the chorion. Spaces between the villi are intervillous spaces which are generally filled with maternal blood.

In our specimen, the chorion appears elliptical in section with a slight concavity on the side on which the embryo is located. The blastocyst was convex on one side before embedding, but, during the process of infiltration, it became somewhat collapsed.

The villi are equally well developed in all parts of the chorion and display dichotomous branching with as many as six branches arising from a single stem. Villi are in different stages of development, and, while their lengths vary considerably, the average length is about 0.7 mm. Although most villi appear as a uniform column of cells, a few are club-shaped; narrow at the base, distended at the tip. In regions where there is sufficient space to develop, the villi are long and narrow, and, when conditions are less favorable, the villi are short and wide.

The chorionic mesoderm is loose and wavy, and is composed of extremely elongated spindle-shaped cells closely applied to the cytotrophoblast, 5 to 15 cells in thickness. A greater concentration of mesoderm is observed at points of evagination into the villa, where it develops cytoplasmic processes. Although the differential staining reaction of the coagulum is similar to that of the cytoplasm of the mesodermal cells, no transition was observed between the nucleated cells and the non-nucleated coagulum.

The cytotrophoblast and plasmoditrophoblast are composed of cubical cells with nuclei of various shapes, alveolar cytoplasm and indistinct cytoplasmic walls. The cytotrophoblast and plasmoditrophoblast of a villus is distinguishable as two distinct layers, except at the tips of the villi where both layers merge together. At the tip of the villus the plasmoditrophoblast becomes enlarged into an alveolar mass containing many large nuclei. Occasionally, the plasmoditrophoblast is observed to originate from the lateral edge of a villus. In smaller villi, the plasmoditrophoblast has a characteristic "brush border."

Many large cells were observed within the syncytium with nuclei in various stages of pyknosis and karyorrhexis. The cytoplasm has shrunk away leaving a large, circular space around the nuclei.

Intervillous spaces near the peripheral incrustation are filled with unclotted blood, while the intervillous spaces near the trophoblast are empty and contain some well fixed and well stained red blood corpuscles.

DISCUSSION: EMBRYONIC DISC, PRIMITIVE STREAK,
AND HENSEN'S NODE

Human embryos of the same age and of different ages display a wide variety of shapes. In general, the younger forms tend to be bluntly oval, while older embryos grow more rapidly in the longitudinal axis than in the transverse axis. Thus, the Mateer embryo is oval, while the older Ingalls and Manchester embryos are elongated. As far as has been determined, all embryos show some degree of convexity. The H. R. 1 embryo is extremely convex in its longitudinal and transverse diameters. Our specimen, because of a sharp posterior ventral flexion appears round when plotted graphically, while the model demonstrates that the germinal disc is slightly longer than broad. The model also displays a mild convexity with a slight marginal concavity where the ectoderm turns upward to form the amniotic ectoderm. The contour of this embryo is normal in every respect. Hensen's node is plainly visible as an elevated and prominent landmark on the disc. Anterior to the disc is a small semicircular depression, probably the primitive pit. No lumen is present.

The disc is composed of overlapping columnar cells with their nuclei placed at different levels within the cells. This modified pseudostratification is common to most embryos; it is specifically mentioned in the Falkiner, Ingalls and H. R. 1 embryos. Unlike the Mateer embryo, the surface of our specimen is not smooth. The contour is uneven and under magnification displays alternate elevations and depressions. In the greater part of the disc, the columnar cells are vertical to the surface; in the posterior flexion, they slant noticeably. The unevenness of the shield and the slanting of the cells is caused primarily by a rapid and uneven rate of growth coupled with a crowding action posteriorly where the flexion is greatest. As a whole, the disc shows an extreme affinity for the basophilic stain which affects both the nucleus and the cytoplasm. Since differentiation between nuclei and cytoplasm is vague, due to similarity of staining reaction, no mitotic figures were observed. Moderate vacuolization was noted in the superficial cells of the disc. Extreme vacuolization and nuclear fragmentation was confined to an area near Hensen's node. Vacuolization of the superficial cells of the germinal disc has been observed in many embryos, and, although considered by most observers as a degenerative phase, still, von Möllendorff (quoted by Johnston, 1940) in de-

scribing similar changes in the Ovum O. P., defended its title to normality.

The absence of mitotic figures, and the presence of vacuolization and nuclear fragmentation is indicative of degenerative changes. This degeneration could have taken place before the fixative had penetrated sufficiently. The detached embryo together with its folded yolk sac lies in the chorion upon a mass of coagulum, opposite its original place of attachment. Since the chorion and yolk sac are well fixed, it is possible that degeneration had set in before the fixative could penetrate the chorion, coagulum, yolk sac and embryonic disc.

The primitive streak in the Mateer embryo is relatively short. In the Ingalls embryo, its length is about a third of the longitudinal axis. Generally speaking, the primitive streak is characterized by the fusion of the ectoderm of the disc with the mesoderm and entoderm. Laterally, it proliferates solid mesoderm for a short distance and, for the remaining part of the disc, the mesoderm is in the form of syncytial loops attached at intervals to the ventral surface of the embryonic disc, and to the entodermal roof of the yolk sac below. The primitive streak of the Falkiner specimen stained intensely; this is at variance with the staining reaction of our specimen.

Hensen's node lies anterior to the primitive streak and slightly to the right of the longitudinal axis. This structure is absent in the Mateer and Ingalls embryos and, while no elevation is prominent in the H. R. 1 embryo, it has been described as the region of the fusion of the germinal disc with the mesoderm and entoderm. In our specimen, Hensen's node is a large and prominent structure.

THE HEAD PROCESS

Hill and Florian (1931-1932) have made detailed studies of the preblastoporic axial structures (head process and prochordal plate) of a considerable number of human embryos. Results of these studies demonstrate that the head process consistently arises as a forward growth from Hensen's knot accompanied by forward extensions of the primitive streak mesoderm. According to Hill and Florian, the head process is divided into three parts; a caudal part, assuming a typical chorda canal; a cranial, short but broad segment as yet undifferentiated; and, an intermediate segment with two lateral mesodermal bands which arise as forward extensions of the primitive streak mesoderm. The cranial part of the head

process is undifferentiated and passes into continuity with the mesoderm of the prochordal plate. The intermediate part, in its early stages of development may have isolated lumina and ventral openings into the yolk sac. This intermediate structure transforms in a caudo-cranial direction into a canal by coalescence of the ventral openings and isolated lumina. It becomes continuous with the chorda canal of the caudal segment. The caudal part is characterized by a cylinder or rod of cells with a chorda canal and dorsal opening (blastopore) situated on Hensen's knot and opening into the amniotic cavity. Heuser (1932) observed that the chorda canal is of short duration because it is already in the process of obliteration before the entire structure is tunneled.

Florian (1930) states that the differences between the Dobbin and the Ingalls embryos are slight. The Dobbin embryo has three isolated lumina and two lateral bands of mesoderm in the intermediate segment, while, in the Ingalls embryo, in this same region (completion plate of Ingalls) one continuous canal is present. He suggests, moreover, that the three lumina in the intermediate segment of the Dobbin embryo would become continuous to form a canal similar to the one in the Ingalls embryo. Heuser (1932) considered the caudal part of the head process of the embryo which he described (The Heuser embryo) to be entirely notochord. The notochord of this embryo is a cylindrical mass of cells with a continuous chorda canal, its width not varying with the width of the node except in the region of the prochordal plate. The head process of the H. R. 1 and Manchester embryos is a very short structure, and, consequently, in an early stage of development. In the Falkner Ovum, the head process is described as a solid uniform rod, composed of at least two layers of closely packed cells. The head process is absent in the Matcer embryo.

In the specimen on which this study was made, the head process is a long, broad, forward growth from Hensen's node. Its lateral margins together with the two caudal extensions are continuous with primitive streak mesoderm. Although the head process thins out before it approaches the prochordal plate, no sharp line of demarcation is found between these two structures. The head process is either continuous or very closely associated with the prochordal plate. It is impossible to distinguish segments or divisions in this head process. Lumina, ventral openings, axial thickening, and blastopore are absent. About a dozen columnar cells were observed in the anterior part of the node, but these cells did not extend beyond the anterior downward slope of the node.

From the comparisons made, it is evident that the head process of this embryo is in a later stage of development than in either the Manchester of H. R. 1 embryos, and definitely not as well developed as in the Ingalls and Heuser embryos in both of which the notochord is an axial thickening with a chorda canal.

THE PROCHORDAL PLATE

The axially placed and thickened patch of entoderm situated anterior to the head process is known as the prochordal plate. The prochordal plate has been studied and investigated extensively in both the vertebrate and invertebrate animals. According to Adelman (1922), in the shark, the prochordal plate gives rise to the premandibular somites. It does not contribute to notochord material, and it is an important site for the proliferation of head mesenchyme. Aasar (1931), in his studies with the rabbit, came to the conclusion that the prochordal plate gives rise to the anterior wall of the foregut, to the homologue of the presomitic mass, and probably to a small part of the oral plate entoderm. He further noted that the prochordal plate is ultimately converted into mesenchyme. Hill and Tribe (1924), working with the cat, have verified the observations of Adelman and Aasar, with the exception that the prochordal plate is continuous with the head process.

In the Dobbin embryo, the prochordal plate is relatively small and indistinct indicating that mesoderm is not being actively proliferated. The prochordal plate of the Ingalls embryo is continuous with the head process, and the transition between the two is gradual. It is composed of closely packed cells distinct from the entoderm and contains numerous chromatophilic granules. No prochordal plate is present in the Mateer embryo. A thickened patch of entoderm in the roof of the yolk sac has been described as the prochordal plate in the H. R. 1 embryo. It consists of 10 to 12 large, round cells. The cytoplasm is vesicular and indistinct and the nuclei are round or oval. Whether or not the prochordal plate is continuous with the head process was not established. According to the authors, the prochordal plate is probably present in the Falkiner embryo. The posterior end of the prochordal plate of the Heuser specimen, on the other hand, merges with the primordium of the notochord. The chordal canal terminates where these two structures merge. Four isolated cavities were also found in the prochordal plate. This prochordal plate was actively contributing to lateral mesoderm.

In our specimen, the prochordal plate has been identified as a

crescentic area of thickened entoderm anterior to the head process. It is broader than in any of the embryos with which it has been compared, an indication that mesoderm was being actively proliferated. It cannot be said definitely that the prochordal plate is continuous with the anterior part of the head process. Both structures are distinct; the transition between the two is gradual. With the possible exception of the area in front of the head process, the peripheral margins of the prochordal plate merge with mesoderm. This prochordal plate consists of typical large entodermal cells with large, round or oval nuclei and with faintly outlined cytoplasm. Neither vacuoles nor chromatophilic granules were observed. This prochordal plate is indistinct from the entodermal roof of the yolk sac. In several instances, the ectodermal cells of the shield seem to fuse with the prochordal cells in the cephalic end of the embryo. The ectodermal cells of the embryonic disc do not enter into the formation of the prochordal plate, since no intermediate types of cells were observed between the short columnar cells of the disc and the typical round cells of the prochordal plate.

THE ALLANTOIS

The allantois is generally a tubular diverticulum which arises as an evagination from the caudo-dorsal wall of the yolk sac. In older embryos, it extends into the body stalk. In recent years, however, it has been observed in a few embryos that the allantois may also arise as a solid cord of cells. It is possible that the allantois has a double origin, as an evagination from the caudo-dorsal wall of the yolk sac, and as a solid cord in the body stalk. Johnston (1940), in discussing the origin of the allantois, believes that it may arise either as a solid cord which later atrophies and disappears, its proximal end forming the site of the hollow allantoic canal, or, it may develop as a solid entodermal rod, or, as a small diverticulum which rapidly enlarges and grows into the connecting stalk.

In the Falkiner Ovum, the allantois is a very long, tortuous structure arising from the ventral compartment of the yolk sac. It terminates in a cone-shaped process growing towards the amnion. The allantois, in the Manchester embryo, arises behind the cloacal membrane as a small area of entoderm from the dorsal wall of the yolk sac. This small area is thickened and in its center is a minute funnel-shaped opening leading into a tubular diverticulum which enters into the body stalk. This opening is the allantoic canal. In the H. R. 1 embryo, the allantois is a solid cord of entoderm aris-

ing in the median plane from the apex of a funnel-shaped diverticulum near the caudal end of the yolk sac. An allantois is present in the Mateer embryo; its lumen is discontinuous. In the Ingalls embryo, the allantois emerges a short distance behind the cloacal membrane and enters the body stalk immediately. At one point the allantois comes in contact with the amnion and opens into the amnion. Ingalls states that this opening is the *canalis amnio-allantoidus*. In the Heuser embryo, the allantois is uniformly thick and is slightly enlarged at its distal end.

In our embryo, a new situation arises with reference to the allantois. The caudal part of the yolk sac, where the allantois is normally found, has been separated from the body proper and all original relationships are destroyed. The distal part of the allantois may be seen, nevertheless, as a solid straight cord of cells extending about half way into the body stalk. It is composed of closely packed rounded cells with oval or round nuclei and distinct cytoplasmic walls. The allantois is discontinuous; a small portion is detached from the main body of the cord, and is separated by mesenchymatous tissue.

Inasmuch as the allantois of this embryo was studied under unfavorable conditions, it is impossible to arrive at any definite conclusions. It is probable that the allantois in this embryo arose from two different sources. It arose as a solid cord in the body stalk and as an evagination from the caudo-posterior wall of the yolk sac. It is probable that the cells in the cord would separate from the center to form a lumen, a stage not yet reached by our embryo. At the place where evagination of the yolk sac would meet the cord, a plate would be formed. Later, this plate would break through and the lumen would become continuous. This postulation agrees with the different stages in the development of the allantois found in the following embryos: the earliest stage, that is, where the allantois is a solid cord, may be found in the H. R. 1 embryo; in the Mateer embryo, the allantois is discontinuous, and in the Manchester embryo, a plate and a small opening has been formed between the body-allantois and the body stalk-allantois; in the Heuser embryo, the allantois is complete.

If this is a true series, the development of the allantois of our embryo is in a stage between that of the H. R. 1 and the Manchester embryos.

THE CLOACAL MEMBRANE

The cloacal membrane has been studied adequately by Florian (1933), who has drawn his conclusions from the study of this structure in a considerable number of human embryos. Although our present knowledge of the primordium of the cloacal membrane is by no means complete, the structure has been studied by different investigators in a sufficient number of human embryos to formulate a knowledge of its component parts, its origin and its individual variations.

The primordium of the cloacal membrane has been defined by Florian as the fusion of the ectoderm of the embryonal shield with the entoderm; this fusion occurs posterior to the primitive streak in the caudal most part of the embryo. Its position in the caudal median axis is an intermediate one. Florian has distinguished three important areas in this region; a caudal part, an intermediate part, and the primitive streak. The caudal part is an area where, in the earliest stages, some of the primary mesoderm is derived from the ectoderm. The intermediate part is the cloacal membrane which is separated from the primitive streak in the early stages of development. The third part is the primitive streak which appears before the development of the cloacal membrane.

In the H. R. 1 embryo the cloacal membrane has been located caudal to the shield and is associated with the terminal end of the allantoic cord. It extends between the allantoic cord and the amniotic covering of the body stalk, caudal to the shield. In the Heuser embryo, the cloacal membrane separates the amniotic ectoderm of the body stalk from the ectoderm of the germinal disc. The cloacal membrane is absent in the Mateer embryo, while in the Ingalls embryo, it is described as lying posterior to the primitive streak.

In this embryo, the cloacal membrane has been torn with the result that the original relationships, for the greater part, are lost. It is divided into three parts; the anterior part remains in its original position; the central part is found on the ventral part of the body stalk, and, the third part is distorted in a fold of the yolk sac. The first part of the cloacal membrane may be recognized as the fusion of the entoderm with the ectodermal cells of the embryonic disc, posterior to the primitive streak. The middle part which is in the region of the amniotic stalk is recognized by the similarity of cells to that of the anterior part of the cloacal membrane found

in the embryo. The third part is badly distorted and may be recognized only by its similarity of cells, and, by its proximity to the embryonic disc.

ANGIOGENESES

An extensive study of angiogenesis and hemopoieses has been made during the past twenty years. Although the interpretations of results obtained by the different investigators are not in complete accord, most, nevertheless, agree on the fundamental points of the origin and formation of blood vessels and blood cells. Sabin (1920) has shown that, in the chick blood vessels, blood cells and plasma are derived from angioblasts, which differentiate from mesenchyme. Bremer (1914), in a study of the origin of umbilical vessels, concluded that the blood vessels in the body stalk arose as funnel-shaped ingrowths of mesothelium covering the body stalk. These primordia by growth and coalescence formed a vascular network. Hertig (1935), in his study of angiogenesis in human and macaque chorions, demonstrated that, in the human chorion, angioblastic masses and mesodermal cells may differentiate either from the central cells of the trophoblastic column during the formation of villi, or from the associated chorionic trophoblast.

According to Sabin, Streeter, and others, blood vessels are formed by anastomosis of the processes of angioblastic strands, and by vacuolization occurring within these angioblastic strands. Anastomosed angioblastic processes condense to form a contour or outline around a central space. Intracellular and probably intercellular vacuoles appear within the angioblastic strands, flow together and coalesce. The wall of the angioblastic strand nearest the lumen disrupts, liberating cells and fluid contained in vacuoles into the lumen. These liberated cells are the red blood cells, while the liquid is the plasma. Later, the intact remaining part of the angioblastic strand becomes endothelial in character to form the blood vessel. Streeter has shown that this method of blood vessel and blood cell formation occurs chiefly in the chorionic membrane and in the villi of the Mateer embryo. In the yolk sac, the blood vessels and blood cells are formed mainly by vacuolization of the angioblastic strands. Angioblastic processes of the type observed in the villi are absent in the yolk sac. In the yolk sac, early blood cell and blood vessel formation is restricted to the caudo-ventral part of the yolk sac.

In the H. R. 1 embryo, no blood islands are present in any part of the chorion; angioblastic strands and vascular spaces are doubt-

ful. Angiogenesis is not well advanced in the Ingalls embryo. Neither blood vessels nor blood cells were found in the embryo proper. In the body stalk, however, are numerous blood vessels filled with nucleated blood cells. The villi contain anastomosing endothelial tubes and occasional angioblastic strands. No description of angiogenesis is made of the yolk sac because it is histologically less satisfactory. In the Mateer embryo, angiogenesis is considerably more advanced than in either the H. R. 1 or Ingalls embryos. In the chorion, all stages were found from simple multi-nucleated strands to the completed endothelial tubes. Within some of the villi a few round nuclei are attached to the endothelial wall or are suspended by slender threads between two endothelial tubes. These attached or suspended cells have been interpreted by Streeter (1932) to be erythrocytes. The body stalk attained the same degree of development as the chorionic membrane and the villi. The parietal mesoblast of the amnion also developed blood vessels. In the yolk sac, angiogenesis is limited to the caudo-ventral half of the yolk sac. All stages from the simple angioblastic strand to the completed tube are present and considerable liquefaction in the angioblastic strands may be observed.

In the embryo on which this study was made, blood vessel formation is found in the chorionic villi, body stalk, yolk sac, and, to a lesser degree, in the amnion. All stages of development may be seen in the villi from the simplest angioblastic strands to the completed endothelial tubes. It is difficult to determine in this early stage of development whether or not the endothelial tubes anastomose. In the older villi, the walls of the tubes are slightly thickened. The development in the villi of this embryo is not as far advanced as the development in the Mateer specimen, in which some of the endothelial tubes contained red blood cells and the angioblastic strands were undergoing extensive vacuolization. Blood cells are absent in the villi of our specimen, and, if the angioblastic strands have begun to form vacuoles, it could not be observed. Angiogenesis in the body stalk of our specimen, however, has attained a greater degree of development than the Mateer embryo. The endothelial tubes are interconnecting, branch freely and contain some few nucleated red blood cells; blood cells are absent in this same region in the Mateer specimen. Blood vessels are being actively formed in the amnion of the Mateer embryo, while this specimen shows little, if any, angioblastic development. On the other hand, our specimen shows greater development in the yolk sac than the

Mateer specimen. Streeter (1920) has confined the angioblastic development in the yolk sac to the caudo-ventral pole, and, in this embryo, angioblastic development is not restricted to any area, while the ventral region of the yolk sac shows the greatest development. All stages from the single monovacuolated strand to the multinuclear vacuolated strand may be observed in the yolk sac. Many solid cysts of mesoderm are also found. In the ventral pole of the yolk sac may be seen a large endothelial tube composed of twelve endothelial cells and inclosing about twenty nucleated red blood cells. This more advanced stage has not been found in the Mateer embryo.

Angiogenesis and hemopoieses in our embryo has reached a more advanced stage of development than is present in either the H. R. 1 or Ingalls embryos. In the Mateer embryo, development is more advanced in the chorionic villi and chorionic membrane, while, in this specimen, development is greater in the body stalk and yolk sac.

AGE OF THE EMBRYO

The method of determining the age of human embryos by comparing the sizes of the embryonic disc has been abandoned because embryos of similar ages varied considerably in the rate of development. Comparison of embryos of unknown age with embryos of known clinical age is a valuable aid but apt not to be correct, since the method employed to determine the age of the known embryo assumes that the clinical history as given by the patient is correct, and that the rate of development in all human embryos is identical. Recently, a new method of determining age has been devised whereby a human embryo is compared with a macaque embryo of known age. This last method basically assumes that the rate of development is identical in both the macaque and human embryo. While either of the last two methods is not a perfect index to the actual age, a combination of the two methods would probably be more accurate than either method alone. In the following discussion, both of these last two methods will be employed in order to ascertain the probable age of our embryo.

The only available clinical data pertaining to the age of this embryo states that menstruation was "7 to 10 days past due." Assuming, then, that the patient had a normal 28 days menstrual cycle, and, as Hartman (1936) has shown that ovulation in women generally occurs midway between the onset of the next menses, then, ovulation would occur on the 14th day. Assuming further

that fertilization occurred on this same day and adding to this the 7 days, the lower limit after the expected appearance of menstruation, the fertilization age of the embryo would be 21 days. If, however, the upper limit of 10 were added to the 14, then the fertilization would be 24 days. Compared with macaque material and with embryos of known age, the upper limit of 24 days is incorrect, while the lower limit of 21 is probable.

Streeter (1920) has classified embryos according to the degree of development present. This classification is divided into 3 groups with 6 stages.

GROUP 1. Embryos in which primitive groove is present.

Stage 1. Villi absent.

Stage 2. Primitive villi present.

Stage 3. Villi having simple branching.

GROUP 2. Embryos in which a primitive groove is present.

Stage 4. Yolk sac larger than amnion. Allantoic duct present. First stages of angiogenesis in wall of yolk sac and chorion.

GROUP 3. In addition to the primitive groove, the embryo has a head process with contained canal.

Stage 5. Prochordal plate and cloacal membrane present. Medullary folds recognizable.

Stage 6. Further differentiation of neurenteric canal. Formation of chordal plate. Gut begins to constrict from the remainder of the yolk sac. Evidence of angiogenesis in body of embryo.

According to this classification, Streeter (1920) has placed the Mateer embryo (17 days old) in Group 3. Angiogenesis is more highly developed in the Mateer embryo than in other embryos in Group 2, and, for this reason, it may occupy a position between Groups 2 and 3. The Ingalls embryo is generally less developed than embryos in Stage 6, more especially since angiogenesis is absent in the embryo proper, it has been placed in Stage 5.

The presence of a head process, prochordal plate, allantois and cloacal membrane, and the absence of medullary folds, places our embryo between Groups 2 and 3, but nearer to Group 3 than to Group 2. Our embryo, therefore, is placed between the Mateer embryo with a fertilization age of 17 days and the Ingalls embryo with a fertilization age of 19 days, but nearer to the Ingalls embryo than to the Mateer embryo. If the fertilization ages of the Mateer and Ingalls were determined correctly, then the age of our embryo is between 17 and 19 days, but since it lies nearer to the Ingalls embryo than to the Mateer embryo, its probable age is 18 days. Furthermore, the Jones-Brewer 1 embryo shows the same degree of development as our embryo with the exception that the Jones-Brewer 1 embryo has an early neurenteric canal. Its fertilization age, clinically determined, is 18½ days.

On the other hand, when our embryo is compared with macaque material, the fertilization age is correspondingly higher.

Hartman (1932) has developed a technique of determining the exact ovulation time in the macaque by recto-abdominal palpation. With controlled fertilization, then, the exact age of the macaque embryos was known. Streeter (1932-'33), observed that the macaque has a similar type of implantation and growth curve and concluded that macaque embryos provide a new means of determining the ages of human embryos. Development is parallel to the human up to the 35th day which corresponds to the human embryo of 12-14 mm., with the only difference in form being the possession of a longer tail. In the macaque, Hensen's node, notochordal process and primitive streak are well developed on the 20th day; on the 22d day, somites appear. Segmentation is rapid since 1 to 8 somites may be found on embryos of the same age.

Comparing our embryo, then, with this limited macaque material, the upper limit of 24 days for the fertilization age is incorrect, since somites which appear on the 22d day in the macaque are absent in our specimen. This fixes the upper limits of its age at less than 22 days. In the macaque, Hensen's node, notochordal process and primitive streak appear on the 20th day. Since these structures are well developed in our embryo, its lower age limit must be 20 days. The age of our embryo, then, would be between 20 and 21 days. Hartman (1936), comparing the Ingalls embryo with macaque embryos, placed its age at 21½ days. In this same compilation, the Mateer embryo remains as originally determined at 17 days. Since our embryo is less developed than the Ingalls embryo, its probable age is between 20 and 21 days.

The age of our embryo when compared with the Mateer and Ingalls embryo is determined to be between 17 and 19 days; when compared with the macaque and the corrected age of the Ingalls, its age is between 20 and 21 days.

SUMMARY

1. A normal human presomite embryo is described.
2. External measurements of blastocyst are 15 x 10 x 5 mm.
3. Angle of section is 34 degrees from the midsagittal plane.
4. Embryonic disc is slightly oval and contains: (a) Primitive streak and groove. (b) Hensen's node and primitive pit. (c) Cloacal membrane. (d) Prochordal plate. (e) An allantois which appears as a solid cord of cells in the body stalk.
5. The yolk sac is larger than the amnion.
6. Villi are well developed and arise as an evagination of the cytotrophoblast and plasmoditrophoblast together with the chorionic mesoderm which forms the core of the villi.
7. Angiogenesis is well developed in the body stalk and yolk sac; less developed in the chorion, villi and amnion.
8. Blood cells are found in the body stalk and yolk sac.
9. The age of the embryo when compared with the Mateer and Ingalls embryos is 17 to 19 days; when compared with macaque material of known age, its age is 20 to 21 days.

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PLATE IV

FIG. 1. General view of embryo as seen in section 62.1, showing ends of broken amnion, embryonic disc, and collapsed yolk sac. The embryo rests upon coagulum in chorionic vesicle. Sections of chorionic villi appear at lower left. $\times 100$.

FIG. 2. Detail from section 63.4, showing upturned rim of amnion and gradual transition of the columnar cells of the germinal disc to fusiform cells on the inner lining of the amnion. Note also fusiform mesodermal cells on the outer covering of the amnion which are continuous with the intraembryonic mesoderm. $\times 560$.

FIG. 3. Photograph of blastocyst, with millimeter scale below.

PLATE IV

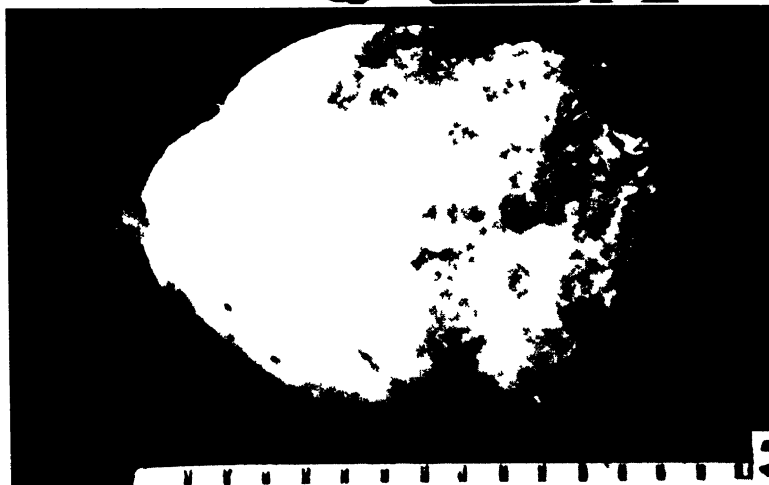
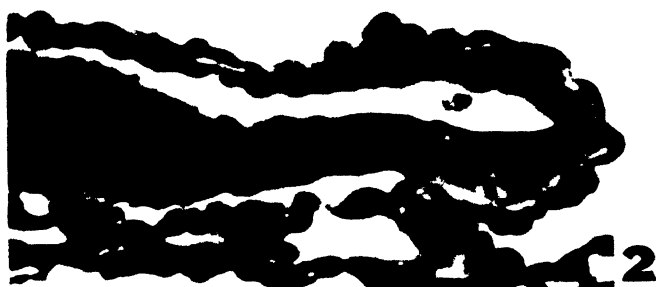


PLATE V

FIG. 4. Detail from section 61.1, showing the protochordal plate below the germinal disc. Note fusion of ectodermal pillar with the anterior part of the protochordal plate. The thickened strand of cells above the germinal disc is the amnion. Cellular detritus may be seen in the amniotic cavity. A part of the yolk sac appears at lower right. $\times 600$.

FIG. 5. Detail from section 63.1, showing cross sections of chorionic villi and chorionic mesoderm. Note blood vessel formation within villi. A group of syncytial cells appears near upper center between two villi. $\times 250$.

FIG. 6. Detail from section 61.11 showing head process and columnar cells below basement membrane of germinal disc and on anterior slope of Hensen's node.

PLATE V

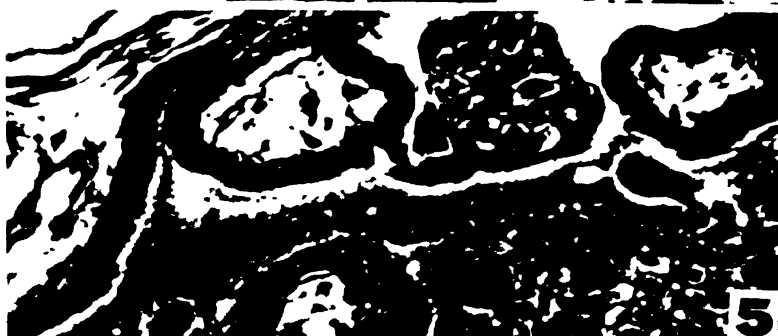
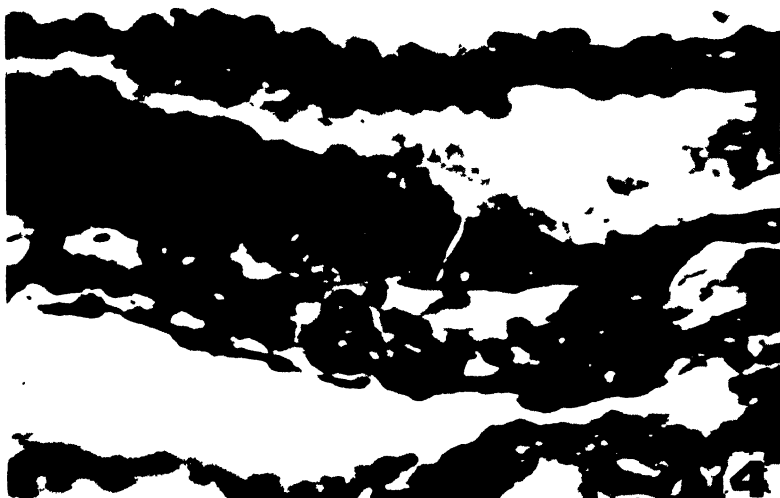
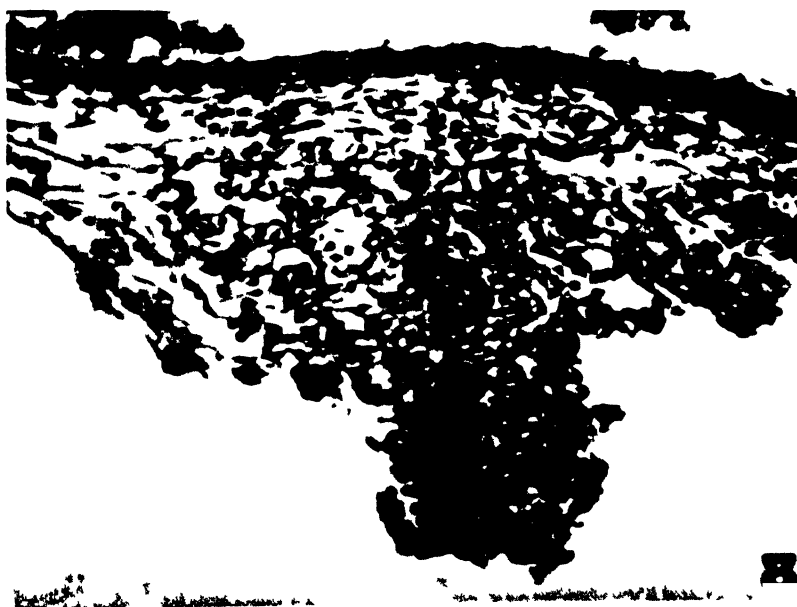


PLATE VI

FIG. 7. Detail from section 62.8, showing mesodermal cyst in the yolk sac. Note also coagulum within and below yolk sac. $\times 600$.

FIG. 8. Detail from section 63.11 showing allantois as a solid cord of cells and an isolated part of allantois dorsal to the cord. Angiogenesis is more advanced in the posterior region of the body stalk than in the anterior region. $\times 230$.

PLATE VI



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Some Comments Upon the Structure of a Pycnodontid Fish from the Upper Cretaceous of Kansas

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ABSTRACT: One of the most complete examples of Pycnodontid fishes yet reported from the Western Hemisphere is described in detail. The specimen, originating from the basal portion of the Fort Hays Limestone Member of the Upper Cretaceous Niobrara Chalk Formation of Trego county, Kansas, consists of an obliquely and dorso-ventrally crushed head and antero-ventral body part. Referred to *Micropycnodon kansansensis* (Hibbard and Graffham), the specimen permits a valid elaboration to the definition of this genus.

While the structure of the cosmopolitan and closely related group of Pycnodontid fishes is still imperfectly understood, *Micropycnodon* is indicated to differ from all of the better known genera in the presence of a dermal, ornamented, sphenotic ossification in the skull roof; the failure of the descending pillar of the sphenotic to articulate with the basiptyergoid process; the posteriorly, unkeeled venter of the braincase; and the nonfusion of the palatoquadrate complex with the ventral cranial basis.

The cranial structure of *Micropycnodon* is here interpreted in support of the recent theses by Westoll and Woodward of Pycnodontid descent through some deep-bodied Chondrosteian stock rather than from any *Lepidotes*-like Holosteian. This latter conclusion is based upon such characters possessed by *Micropycnodon* and all other Pycnodontids as the retention of the enlarged, preopercular cheek-plate; the short and posteriorly expanded parasphenoid; and the persistence of the large interorbital fenestra. The high supraoccipital crest; the shortness of the otic crest; the shallow posttemporal fossae; the reduction of the operculae; the apparent absence of a basisphenoid; and the form of the mesethmoid are explained as features developed in response to the deep-bodied adaptation. Such additional Pycnodontid features as the complete reduction of maxillae; the position of foramina for the internal carotid and first efferent pseudobranchial arteries; the position of the basiptyergoid processes; and the absence of clavicles have been noted in other deep-bodied "Sub-holosteian" fishes whose Chondrosteian affinities are undoubted, and seem not unlikely explained as convergences to the typical Holosteian condition. In conclusion, the high, coronoid-like processes on the dentary elements of the Pycnodontids strongly suggest the secondary maxillary articulation of the mandibular rami possessed by *Dorypterus* whose relationship with the Chondrosteian *Bobasatrania* has received wide acceptance.

INTRODUCTION

THE remains of Pycnodontid fishes have been known from North America since 1857, at which time they were reported by Emons from North Carolina and by Leidy from the Cretaceous rocks of New Jersey. They have consisted chiefly of numerous isolated teeth and disassociated dentigerous splenial- and vomerine plates, which students have assigned to a number of genera and many species. Insofar as the present writers have been able to determine neither a complete skull nor fish from this continent has been described or collected. Of interesting moment, therefore, was the recent discovery of the most complete example of one of these deep bodied fishes yet known from the Western Hemisphere in the possession of Mr. George F. Sternberg of Hays, Kansas. Promising to offer considerable morphological information this example has been purchased and is now among the large, important collection of Cretaceous fishes at the University of Kansas Museum of Natural History.

The specimen (KUMNH No. 7030), referred to *Micropycnodon kansasensis* (Hibbard and Graffham, 1941) (see Hibbard and Graffham, 1945) was recovered by Mr. Sternberg between 1934 and 1936 in sec. 21, Twp. 13 S., R. 21 W., Trego county, Kansas, or roughly 5 miles south and $4\frac{1}{2}$ miles east of Ogallah, Kansas. The exact horizon from which the specimen was taken is doubtful, but apparently, as the type specimen, originated in the basal portion of the Fort Hays Limestone Member of the Upper Cretaceous Niobrara Chalk Formation.*

The preserved obliquely and dorso-ventrally crushed head and antero-ventral body part had been mounted in a plaster panel with the left side exposed. In preparation, the plaster was carefully removed from the embedded right side. The structures thus revealed not only add to our knowledge of this specific form but also present a number of morphological features at wide variance with those of the few Pycnodontids yet known in detail. Although certain observations are noted, any general phylogenetic conclusions are discouraged by an almost total lack of cosmopolitan comparative material. The following descriptive account is offered, mainly, in the hope that it may be of aid in some future revision of the entire family Pycnodontidae.

* Sternberg, G. F. in *littoria*, 1944.

DESCRIPTION

The skull shows well the characters of the Pycnodontid fishes. Its component elements have been unusually modified, presumably in response to the deep-bodied adaptation. No traces of the lateral line sensory organs can be detected preserved on the heavy bones. As a result of these two facts, the names here given the various ossifications are based solely on the bone's relative position and are not intended to imply conclusive homology with those of other Actinopterygians. Apparently about twice as deep as long, the frontal profile of the head continues, in a gentle convexity, the sharp angulation of the dorsal body ridge far antero-ventrally to the normally small and slightly uptilted cleft of the mouth. The present specimen possesses an approximately equal size with that of the type specimen (Hibbard and Graffham, 1941). The taking of exact overall measurements is not possible because of the oblique dorso-ventral crushing and consequent dislocation of parts. The following dimensions of individual structures, however, are offered for aid in establishment of general comparative proportions:

Median longitudinal length of the skull roof measured dorsally over the greater external curvature.....	111 mm.
Median longitudinal length of the ventral cranial basis, measured as preserved	89 mm.
Greatest overall length of the vomerine plate.....	30 mm.
Length of the principal row of vomerine teeth.....	18 mm.
Length of the principal row of splenial teeth.....	13 mm.

The primordial neurocranium is extensively ossified. Its bone is heavy and appears to be histologically composed of a very thin and delicate investment of dense lamellar bone upon a thick body of highly cancellous tissue. While there are some indications of radiating growth lines preserved upon the remnants of the external lamellar bone, no discrete sutures can be discerned with certainty, and any reference, therefore, in this paper, to separate endocranial elements is meant only to imply gross neurocranial regions. It may prove permissible to assume a complete fusion between all of the centers of ossification within this primary complex. Furthermore, in the temporal and occipital regions the neurocranium seems to be firmly attached to the dermal bones of the skull roof. No such fusion between the neurocranium and dermal bones is apparent anteriorly, however, and the primary sphenethmoids undoubtedly articulated with the skull roof, the parasphenoid, and the so-called fused prevomers through the intermediary of cartilage.

In general proportions the neurocranium is long and exhibits an almost uniform low height longitudinally because the forward tapering from the occiput to rostrum is slight. The apparent shortness of the skull results from the inclination of the ventral cranial basis, which roughly parallels the frontal profile of the head and is thus extended antero-ventrally from posterior articulation with the vertebral column in an angle of about 30 degrees from the horizontal. The greatest depth is attained posteriorly where in the parietal region the roof is produced in a high median longitudinal crest. The greatest width occurs in the transverse plane of the postorbital processes. In this latter plane the skull roof is broadened into an essentially flat frontal table. Forward from the preorbital processes the neurocranial roof lies almost vertically and rapidly narrows to its antero-ventral extremity in a roundly and externally convex ridge.

The ventral cranial surface is relatively narrow; being only a rounded ridge beneath the occipital and temporal regions and only slightly expanded beneath the orbital and ethmoidal portions of the braincase. The greatest ventral breadth is attained anteriorly but this is attributable to the expanded tooth-bearing portion of the dermal vomerine plate.

In a detailed description of the various neurocranial regions, the occiput, in posterior view, is irregularly quadrangular, with acute supraoccipital, obtuse basioccipital, and equal lateral exoccipital angles. The face is divided into subtriangular halves by a distinct median vertical crest. Each half is directed postero-laterally and a little upwardly. Such structural details as the foramen magnum and the notochordal pit have been obliterated by crushing. The former, however, appears to have been entirely surrounded by the exoccipitals. Immediately above the presumed position of this opening and on either side of the median crest two pairs of small foramina are well preserved which are here determined as points of emergence for some spino-occipital nerves. The vagal canals open far laterally on the exoccipitals behind the labyrinth region, and just above the lateral wall of the basioccipital. The post-temporal fossae appear as only shallow depressions situated ventro-laterally beneath the posteriorly projecting edge of the dermal roofing bones on the dorsal supra-occipital portion of the occiput. A deep postero-ventral groove on the body of the basioccipital part indicates the probable course of the efferent arterial canal. No distinct ventral keel is apparent upon this part.

The lateral wall of the primordial neurocranium is low, short, and its exposed external face is directed ventro-laterally. This

surface is in rounded confluence with the posterior occipital face ventrally, but dorsally meets the latter in a sharp angle beneath the postero-lateral tips of the supratemporals. Dorsally, the median portion of the lateral wall is depressed to considerable extent beneath the overhanging edge of the temporal roofing bones. In contrast the descending lateral wings of the sphenotic anteriorly and of the supratemporal posteriorly stand out as prominent vertical strengthening pillars for the neurocranium. The articulatory facet for the hyomandibular extends across both the anterior and posterior prominences and into the central concavity as well. The proximal head of the hyomandibular exhibits a complementary development. Little or no space remains for the origin of the dorsal temporal muscles within the above described concavity and some reasonable doubt, therefore, may be expressed that it is the homologue of the lateral temporal fossa of related ray-finned fishes.

The proötic portion of the neurocranium appears to be restricted; being limited in front by the ascending wing of the parasphenoid which articulates dorsally with the sphenotic, and limited behind by the massive development of the basioccipital. One large foramen, to be identified as the posterior opening of the jugular canal, penetrates the lateral wall in this region. An antero-dorsal notch in the margin of this foramen indicates the hyomandibular branch of the seventh nerve, and a poorly preserved groove in the antero-ventral margin perhaps transmitted either a postpalatine branch of the seventh nerve or an orbito-nasal artery. The myodome is only slightly exposed through displacement of the parasphenoid. It appears to have been well developed in the normal relationship to the basioccipital, proötics and parasphenoid.

In the orbital and ethmoidal regions, the neurocranium is much compressed from side to side. The interorbital septum appears to have been extensively interrupted ventrally by a fairly large interorbital fenestra and by the anterior openings of the trigemino-facialis chamber and the myodome. The sphenoidal ossifications have been badly fragmented and no positive information can be offered concerning them. Each frontal, however, bears a ventral longitudinal flange which must surely have served as a dorso-lateral support for the sphenoidal bones. The primary mesethmoid is an excessively thin triangular element. Its antero-dorsal margin is firmly wedged between ventrally projecting flanges of the dermethmoids. The ventral margin, on the other hand, is grooved for the firm lodgement of the median dorsal and longitudinal crest of the parasphenoid and vomer.

The shape and arrangement of the dermal roofing bones may be seen in Figs. 1 and 2. The extrascapular series consists of presumably three pairs of short, wide elements. A transverse series of 4 bones occurs in the region normally occupied by the parietals: a median row of 2 and one lateral pair. The posterior of the 2 median plates is roughly twice as long as its greater anterior width. The smaller anterior median element is regularly rhomboidal with angles disposed anteriorly, posteriorly, and laterally. In longitudinal sequence these bones are here arbitrarily termed dermsupraoccipitals and are designated by the exponents 2 and 1, respectively. The paired lateral elements are situated in the position of parietals but are widely separated from contact with the frontals by a great posteromedian production of the intertemporals. The frontals are the largest bones of the skull roof. Their anterior widths are more than twice their posterior widths and this maximum breadth is contained twice in the greatest overall length of the bones. The dermethmoids are paired and are sharply depressed, laterally. A deep pit occurs low on each, ventro-laterally, into which the olfactory canals emerge. The antero-ventral extremities of these bones also exhibit a thickened, antero-laterally directed facet for an assumed articulation with an as yet unrecognized premaxillary.

Regarding the temporal bones, the anterior intertemporal is the next largest element in the roofing complex. It forms the superior border of the orbit and is extended far posteriorly, articulating with the frontal and anterior dermsupraoccipital mesially and with the second dermsupraoccipital and parietal posteriorly. In contact posterolaterally is a small dermsphenotic roofing the postorbital process, and a large supratemporal which forms the greater part of the short lateral temporal margin of the skull roof. The posterolateral angle of the latter plate is slightly embayed for an articulation with the suprascapular bone.

The dermal parasphenoid, flooring the primordial neurocranium, has been twisted and somewhat fragmented in its short postorbital part. It is evident, however, that this region is produced into a high lateral wing on either side which articulates dorsally with the sphenotic and forms more ventrally the antero-lateral edge of the myodome. Only a low, obtuse ventral keel is developed on this part constituting the floor of the eye muscle chamber. The basipterygoid process is a long, tumid prominence situated laterally on the ventral body of the element just below the ascending wing. The first

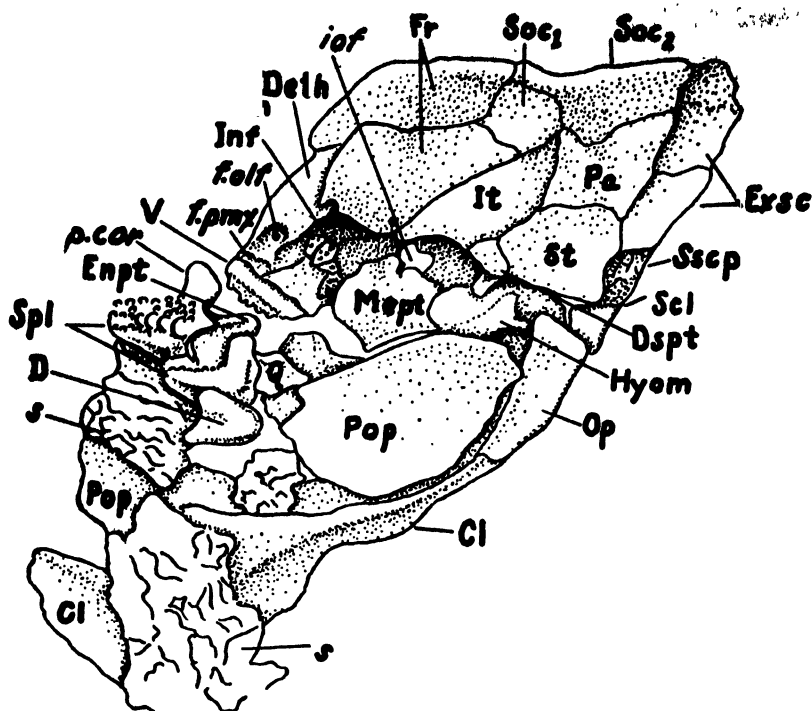


FIG. 1. *Micropycnodon kansasensis* (Hibbard and Graffham) (KUMNH. No. 7030). Habit sketch of the head and opercular regions from the left side. Reproduction approx. $\times \frac{1}{2}$.

Legend of Abbreviations: Cl, cleithrum; D, dentary; Deth, dermethmoid; Dspt, dermsphenotic; Enpt, entopterygoid; Exsc, extrascapular; f. olf, olfactory foramen; f. pmx, articular facet for the premaxilla; Fr, frontal; Hyom, hyomandibular; Inf, infraorbital bone fragments; iof, interorbital fenestra; It, intertemporal; Mept, metapterygoid; Meth, mesethmoid; Op, operculum; Pa, parietal; p. cor, coronoid-like process on splenial; Pop, preoperculum; Q, quadrate; s, disassociated scales and plates; Scl, supracleithrum; Soc₁ and 2, anterior and posterior, respectively, dermsupraoccipitals; Ssep, suprascapular; St, supratemporal; and V, vomer.

effluent pseudobranchial artery was transmitted along a groove antero-dorsally to this process. The anterior suborbital portion of the parasphenoid is long. It bears a relatively high dorsal keel, a low ventral keel, and somewhat expanded lateral edges. A distinct groove obliquely traverses the lateral margin for the passage of the anterior palatine nerve. The anterior extremity beneath the mesethmoidal overlies the postero-median limb of the vomer.

The vomer is a single bone. It has a stout anterior portion, ventrally expanded and tooth bearing; and an attenuated posterior extension which arises at no great angle from the forward body.

maxillaries and maxillae have not been recognized. A few small, polygonal and externally ornamented plates, however, remain crushed down upon the endocranial structures, and these undoubtedly represent the degenerate, subdivided infraorbital and suborbital bones. Of dorsal and ventral ossifications, the present fish retains only the ventral preopercular plate. This is greatly expanded, and tapers both above and below. The antero-mesial margin is thickened and vertically grooved, apparently for a firm articulation with the suborbital cheek scales. The reduced operculum is deep but very short, and is in wide contact with the antero-mesially lying hyomandibular. Subopercular and interopercular are, as normally, absent.

By reason of histological structure, two replacement ossifications of the visceral skeleton have been determined which are here tentatively referred to the mandibular arch and termed articular and quadrate because of their shape and relationship to the left splenial bone. The right splenial bears a vertical crest postero-mesially. The lateral face of this ridge is longitudinally rugose, indicating an overlapping articulatory area. The element here termed the articular occupies this position on the left mandible, although somewhat displaced, and is, posteriorly, dorso-ventrally constricted but transversely expanded into a concave facet. The so-called quadrate lies immediately behind the articular, and crushed laterally upon the left splenial. It is a triangular bone with a thickened apical condyle ventrally, and thin expanded dorso-mesial part. On this latter the posterior margin is produced into what may be arbitrarily called a symplectic process for supporting abutment against the hyomandibular.

The suspensorium is inclined far forward. The hyomandibular exhibits a great lateral compression but with a longitudinally expanded head and attenuated antero-ventral limb. The head is produced into a high peak for insertion into the lateral temporal indentation on the neurocranium and both the anterior and posterior slopes of the peaks are faceted for articulation with the vertical sphenotic and supratemporal prominences, respectively. The axis of the ventral limb is continued on to the lateral face of the proximal head in the form of a distinct and broad ridge whose faceted dorsal extremity constitutes a modified opercular process. The foramen for the hyomandibular ramus of the seventh nerve emerges in the middle of the element's height just anterior to the lateral strengthening ridge.

The dermal bones in each ventral half of the mandibular arch apparently numbers only two: a lingual splenial and a lateral dentary. The splenials are robust. Their symphyseal margins are long and deep. Their outer labial edges diverge widely from the median line to enclose broad dentigerous dorsal tables. The dental batteries are flat in their anterior portions but postero-laterally the surface of the teeth are rotated and the individual denticles are directed upwardly and posteromesially. The teeth are set in one principal row of 6 teeth on both the right and left splenial. The longer transverse axis of all the teeth of the principal row are at right angles to the antero-posterior line of the symphysis. The most posterior tooth of the principal row is considerably the larger and is transversely ovate in shape measuring 4.5 mm. in greatest diameter. The teeth decrease in size anteriorly. The anterior two are round in outline, and approximate 1.3 mm. in diameter. A small inner row of teeth is present lingual to the principal row. On the left splenial there are 5 teeth in the inner row which is parallel to the principal row, while on the right splenial the inner row consists of 6 teeth irregularly set. These inner rows of teeth begin at the anterior end of the splenial and extend backwardly one-half the length of the principal row. Paralleling the principal row of teeth labially is a row of 9 teeth on the left splenial and a slightly irregular row of 9 teeth on the right splenial. Along the outer edge of the left splenial is a row of 7 teeth while along the outer edge of the right splenial there is a row of 8 teeth. Crowded between the last four posterior outer teeth and the foremost posterior teeth of the row just labial to the principal row are 5 small teeth in the right splenial; while on the left there are 6 small rounded teeth crowded in between the three most posterior teeth of the two rows labial to the principal row. The teeth of the labial row on each splenial are rounded, more uniform in size than those of any other row. They are also larger than the other teeth except those of the principal row. The anterior tip of the splenials are missing and the presence of some of the teeth are known only from their broken bases. The small and medium sized teeth in all rows possess an apical pit with radial crenulations. The postero-lateral angle of the splenial is dorsally produced into a high, laterally compressed coronoid-like process. Between this and the postero-mesial crest described above occurs a deep notch which is the only preserved evidence of the Meckelian orifice. Ventro-laterally, the element is deeply excavated throughout its length by the Meckelian groove. The dentary is a

free and externally ornamented plate which corresponds in outline to the lateral aspect of the splenial. The bone is ventrally thickened for an assumed ventro-mesial contact with the articular. No traces of teeth are to be seen on its oral border; the latter apparently in corollary to the degeneration of the cheek and lateral tooth-bearing bones of the upper jaw.

In the dorsal palato-quadrato half of the mandibular arch, both right and left bones are preserved which occupy the position of metapterygoids. Each bears mesially a longitudinally grooved projection which abuts against the basipterygoid process of the parasphenoid. In direct contact anterior to the displaced right metapterygoid is a weak ossification with thickened and produced mesial margin which may prove to be an entopterygoid.

Numerous small polygonal plates invest the gular region. As preserved these are disassociated and any branchiostegal rays, if present, cannot be distinguished. As stated in the introduction no evidences of lateral line sensory organs can be ascertained. All of the external bones of the head are ornamented with irregularly scattered, small conical tubercles of enamel. These in turn are radially striated and contain a hollow internal cavity at their bases.

The short, low suprascapular does not appear to possess a median dorsal supraoccipital attachment. A rounded anterior margin indicates only a postero-lateral supratemporal articulation. The supracleithrum is a short and simply deepened element largely covered by the opercular plate. The cleithrum is very high and presents only a short thickened ridge externally in its dorsal part but below the broad embayment for the pectoral fin is somewhat expanded. A frontally thin but transversely broad flange is developed mesially from the anterior margin of this bone. The primary shoulder girdle is largely covered but is well ossified. The pectoral fin is situated at moderate height upon the anterior flank of the fish. Its dermal rays bifurcate; are not in their proximal part at least articulated; and seem to far exceed in number the radial elements.

The preserved antero-ventral portion of the body is completely encased in heavy rhomboidal scales. These, however, break up into small plates near the origin of the anal fin and it may be that the caudal pedicle was unarmored. The central flank scales are about 3 times deeper than long but diminish in height both dorsally and ventrally. Considerable subdivision appears to have taken

place in the most distal antero-ventral body part. The flank scales are widely imbricating. Their antero-dorsal angles are produced into stout pegs which are externally overlapped by the produced antero-ventral angles of the dorsally succeeding scales. These scutes are essentially smooth except for an occasional enameled tubercle. Heavy spinous ridge scales are developed ventrally.

REMARKS. With the single exception of *Gyrodus macrophthalmus cubensis* Gregory (1923) all of the numerous Pycnodontid fishes described from North America are based upon varyingly complete vomerine and splenial dentitions. These being generally disassociated, they offer slight insight into the breadth of structural variation within the group and any current attempt to decipher even taxonomic relationships is difficult. The dental characters of the associated vomerine and splenial plates of *Micropycnodon kansasensis*, however, appear to present a combination of features separate from all previously described American Pycnodonts except possibly *Gyronechus dumblei* (Cope, 1892 and 1894). The latter form may ultimately prove to belong to the genus *Micropycnodon* but is for the present considered a distinct species because of its greater regularity of the tooth row arrangement and because of the absence of a broad untoothed area between the symphysis and the principal tooth row posteriorly as displayed by *Micropycnodon kansasensis*.

The Pycnodontid fishes have been long recognized as a closely related group exhibiting marked variation of detail despite our still imperfect knowledge of many major points in their structure. *Mestrusus* (Woodward, 1895, 1896, and 1917) is the most completely described as regards the morphology of the head with a few features having been added from such European forms as *Gyronechus*, *Proscinetes*, *Gyrodus* and *Anomoeodus*. *Micropycnodon* differs in many respects from characters apparently held in common by all of these better known genera. Among these differences possessed by *Micropycnodon* effecting the present definition of the group may be noted the presence of a dermal, ornamented, and roofing portion of the sphenotic; the descending ventro-lateral pillar of the sphenotic which while articulating with the ascending wing of the parasphenoid does not reach the basipterygoid process; the posteriorly unkeeled venter of the braincase; and the non-fusion of the palato-quadrate with the ventral cranial basis.

These deep-bodied fishes of the family Pycnodontidae were originally considered relatives of the Platysomidae. Later restudied by

Tracey and followed by Woodward, an alternate thesis was developed which postulated that the Pycnodont ancestors were to be found among the deep-bodied and small-mouthed *Lepidotes*-like Holosteans. The latter concept has never been realized and recently Westoll (1937, 1941) and Woodward (1939) abandoned it in favor of descent from deep-bodied Chondrosteian stock through some "Sub-Holostean" stage.

Their conclusions, based upon comparative osteological criteria, are strengthened in those few pertinent characters displayed by the present parital specimen of *Micropycnodon kansasensis*. These Chondrosteian features are, namely: the enlarged preoperculum which in retaining the essential nature of a cheek plate seems necessarily derived only from some condition similar to that suggested by the older genera *Bobasatrania*, *Cleithrolepis* and *Aetheodontus*; the development of the parasphenoid which is short but highly expanded in the posterior portion; and the persistence of a large inter-orbital fenestra. The supraoccipital crest; the shortness of the otic crest; the slight depression of the posttemporal fossae; and the reduction of the opercular apparatus following a probable anterior shifting of the branchial chamber seem to be changes in response to the deep-bodied modifications. The apparent absence of basisphenoid, and the form of the mesethmoid noted by Dyne (1939) as perhaps peculiar to *Amphicentrum* but noted also in this Pycnodont, may possibly prove more common in deep-bodied fishes than now known. Such Holostean-like characters displayed by this Pycnodont as the loss of the maxillae after the reduction from firm posterior articulation with the preoperculum; the position of the foramina for the internal carotid and first efferent pseudobranchial arteries; the position of the basipterygoid processes; and the absence of clavicles have been noted in other deep-bodied fishes of undoubted Chondrosteian affinities (Westoll, 1941). In the light of the recent studies by Brough, Stensiö, Westoll and others on the many "Sub-Holostean" lines of development these Holostean-like characters seem not unlikely explained as convergences.

As regard phylogeny, the suggested similarity between the Pycnodontid fishes and *Bobasatrania*, *Cleithrolepis* and *Aetheodontus* have been discussed by Woodward (1939). These genera, in part, have received some acceptance as Platysomid derivatives. Westoll (1941) called attention to the relationships of *Dorypterus* to *Bobasatrania* and further postulated some affinity, however distant, between *Dorypterus* and the Pycnodontid fishes. Some credence is

given the latter concept by the structure of the lower jaw of *Micro-pycnodon* with a posterior articular and a more anterior coronoid-like process which is suggestive of the secondary maxillary articulation in *Dorypterus*. Maxillae remain unknown in the Pycnodonts but conceivably some ligamentous connection with another part of the palato-quadrate complex may have been retained. The designation of a definite Pycnodont ancestor, however, seems premature. The details of Pycnodont morphology are still too imperfectly known. In addition, there is no assurance that all deep-bodied Chondrosteian stock is of monophyletic origin (Moy-Thomas and Dyne, 1938).

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PLATE VII

Microptycnodon kansasensis (Hibbard and Graffham) (KUMNH. No. 7030)

UPPER. Photograph of the entire preserved portions of the specimen from the left side. Reproduction slightly more than $\times \frac{1}{2}$.

LOWER. The preparation of the head from the right side. Reproduction slightly more than $\times \frac{1}{2}$.

PLATE VII

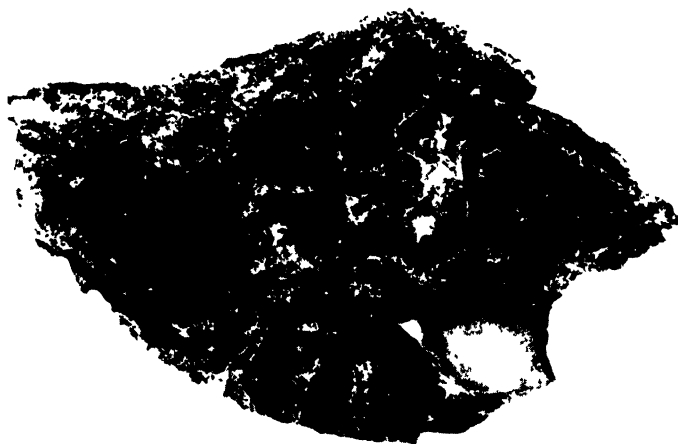


PLATE VIII

Micropterygenodon kansasensis (Hibbard and Graffham) (KUMNH. No. 7030)

UPPER. Crown view of the left and right splenial bones. Reproduction approx. $\times 2\frac{1}{4}$.

LOWER. Ventral view of the left and right splenial displaying the displaced left dentary. Reproduction approx. $\times 2\frac{1}{4}$.

PLATE VIII



PLATE IX

Microptycnodon kansascensis (Hibbard and Graffham) (KUMNH. No. 1019F,
Type Specimen)

FIG. 1. Anterior part of skull with dermal covering removed showing suture between frontals and dermethinoids. Reproduction approx. $\times 1\frac{3}{4}_{17}$.

FIG. 2. Anterior part of skull with vomer. Reproduction approx. $\times 1\frac{3}{4}_{17}$.

FIG. 3. Vomer with dental battery. Reproduction approx. $\times 3\frac{1}{2}_{17}$.

FIG. 4. Disassociated scales from the opercular region. Reproduction approx. $\times \frac{1}{2}$.

PLATE IX



THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

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MAY 1, 1946

[No. 9

Kansas Plants New to Kansas Herbaria

W. H. HERR, Department of Botany

ABSTRACT: The following ten species are listed as new records for Kansas: *Botrychium dissectum* Spreng, *Elocharis rostellata* Torr, *Scirpus occidentalis* (S. Walts) Chase, *Leersia lenticularis* Michx., *Erythronium americanum* Ker., *Lamium purpureum* L., *Physocarpa intermedia* (Rydb.) C. K. Schneider, *Chaetopappa asteroides* DC., *Bidens laevis* (L.) B.S.P., and *Senecio glabellus* Poir.

Botrychium dissectum Spreng. Two specimens were found October 8, 1942, growing in wet forest-covered bottoms along the Marais des Cygnes river on the Hugh Whiteford ranch in Miami county. Subsequent searches in that area have not produced any additional specimens. This plant probably occurs in other places along the east edge of this state. It has been reported from Wyandotte county, but there is no specimen on file. It has been collected over an area extending from Maine and Virginia on the east to Minnesota, Iowa and Missouri on the west. These specimens extend the distribution farther west than any previous collection in the plains states.

Elocharis rostellata Torr. The first specimen of this plant was brought in from Meade County State Park by Doctor C. W. Hibbard in 1942. In September of 1944 it was found in the margins of the artesian-fed ponds and seepy places in several localities in that county. Other botanists have collected this plant in nearly all parts of the United States. The artesian spring-fed ponds provide an ideal place for this plant to grow and it should be found in other marshy places in Kansas.

Scirpus occidentalis (S. Walts) Chase. This plant was found on September 16, 1944, growing in the sandy bottoms along the Cimarron river in Meade county. It is so much like *Scirpus validus* Vahl that it has probably been mistaken for *S. validus* and thus missed. This plant has been collected on all sides of Kansas and should be found in other parts of this state.

Leersia lenticularis Michx. On September 20, 1938, this plant was first found in wet open places in the forest growth along the Marais des Cygnes river in Miami county, east of Fontana. It was collected in quantities in the same area on September 19, 1941. This

wet river bottom is an ideal habitat for this plant which grows only in such places. It has been collected from Minnesota, Missouri, Texas and states east to Indiana, Virginia and Florida.

Erythronium americanum Ker. In May of 1940 this plant was found in Oklahoma just south of Cherokee county. In April of 1941 it was collected in quantities in several places along Shoal creek in Cherokee county. This brings its range a little farther west than has been previously reported. It has been collected from Minnesota to Texas, and east to the Atlantic Ocean. As it thrives only in moist habitat such as exist in the Ozark region of Cherokee county, it probably will not be collected very much farther west in this state.

Lanum purpureum L. This plant has been growing in an open woods just east of Lawrence for the past twenty-five years and probably longer. It was collected in quantities by R. L. McGregor on April 24, 1940. It has been collected in fields and waste places from Missouri east to North Carolina and Newfoundland. Here in Kansas it grows in a more sheltered place.

Physocarpa intermedia (Rydb.) C. K. Schneider. A few bunches of this shrub are growing in the southeast corner of Cherokee county in moist open woods where it was collected on May 8, 1943. Other collectors have found this plant in Colorado, North Dakota, Missouri and states east to western New York. The Ozark region of southeast Kansas provides an ideal habitat for this plant.

Chaetopappa asteroides DC. Collected on July 7, 1937, in a dry, sandy creek bed seven miles southwest of Neodesha in Wilson county. This plant grows in Missouri, Oklahoma, Texas and northern Mexico and probably will be found in other places in Kansas.

Bidens laevis (L.) B.S.P. This plant has been reported from Kansas by other authors. It was collected on September 18, 1945, along a stream just below Lake Larrabee in Meade county and should occur in wet meadows and swampy places in other parts of this state, especially in the eastern part as it grows in similar habitats from Missouri east to Massachusetts and south to Texas.

Senecio glabellus Poir. Collected on May 7, 1943, along the highway in the Neosho river bottom just east of Chetopa in Cherokee county. There was a large colony made up of thousands of plants. I have not seen it in any other locality in Kansas, but it should be found elsewhere as other collectors have found it in Missouri, Oklahoma and in other states east to Florida and south to Mexico.

This work was supported in part by a grant from the Graduate Research Fund of the University of Kansas.

THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

VOL. XXXI, pt. I.]

MAY 1, 1946

[No. 10

Notes and Descriptions of *Ambrysus* Stål With an Account of the Life History of *Ambrysus mormon* Montd. (Hemiptera, Naucoridae)

By ROBERT L. USINGER, University of California

ABSTRACT: The genus *Ambrysus* is widely distributed in the temperate and tropical regions of the Western Hemisphere. *Ambrysus mormon* Montd. is the commonest species in the western United States. It prefers quiet or slow moving water along the edges of streams. Eggs are laid on pebbles. The life history from egg to adult required 105 days at Davis, California. Distributional records are given for *A. pulchellus* Montd., *pallidulus* Montd., and *pubicus* Stål. The following new species are described: *Ambrysus infuscatus*, *barberi*, *caliginosus*, *fossatus*, *hungerfordi*, *woodburyi*, *bohartorum*, *convexus*, *fuscus*, *buchnoi*, *variegatus*, *sonorensis*, *lunatus*, *lundbladi*, *hintoni*, and *vanduzeei*.

Ambrysus Stål is the type genus of the subfamily Ambrysinæ Usinger. Its position within the subfamily and its relationship to other Naucorids are discussed fully in an earlier paper (Usinger, 1941). *Ambrysus* is one of the dominant groups of water bugs throughout the Sonoran and Neotropical regions of the Western Hemisphere. It occurs from Argentina to Northern California and Wyoming but is replaced in the eastern half of the United States by the genus *Pelocoris*, which pertains to the subfamily Naucorinae.

The genus *Ambrysus* includes about thirty described species. This number could be doubled on the basis of material which is now before me, but I have chosen a conservative course, electing to describe only very distinctive forms which, in most cases, are represented by long series of specimens. With the addition of sixteen new species at this time the genus bids fair to become the largest in the family, and Montandon's two revisions (1897 and 1909) are rendered practically useless. However, a complete revision of the group must await much needed basic research on the limits of variation within such plastic groups as the *signoreti-mormon* complex. Without such a background it will be difficult to interpret the various degrees of differences seen in series of specimens from widely scattered localities.

ACKNOWLEDGMENTS

So many persons have assisted in the course of my twenty years of work on the Naucoridae that it is quite impossible to express my appreciation individually. By far the largest collection in the world is that accumulated by Dr. H. B. Hungerford and his associates at the Snow Museum, University of Kansas. This collection and the U. S. National Museum have been the chief sources of material other than my own collection. Dr. H. B. Hungerford heads the list of persons whose encouragement and coöperation have helped so much in the course of the work. Dr. H. E. Hinton was my companion on a collecting trip to the District of Temascaltepec in Southern Mexico during May, June and July, 1933, which netted several thousand Naucorids representing twenty-one species, six genera, and four different subfamilies. Dr. O. Lundblad of the Naturhistoriska Riksmuseum in Stockholm kindly compared a series of doubtful forms with Stål's types. To these and others mentioned in the course of the present work, I express sincere thanks.

Ambrysus mormon Montd.

This is the commonest and most widely distributed species in the Western United States. I have collected specimens from the type locality, St. George, Utah, which appear to agree in every respect with specimens from the central valleys and north coastal regions of California. To the north and east a smaller and slightly darker form, *heidemanni* Montd., occurs in the warm water streams flowing out from the hot springs of Yellowstone National Park. In California local forms have developed in special restricted habitats such as Clear Lake, Lake county, and Eagle Lake, Lassen county.

Mormon occurs typically in streams with pebble bottoms. In California the Eel river in the north coastal redwood region, the American river in the Mother Lode foothill region and Putah creek in the Sacramento Valley offer perfect conditions for this species. The bugs swim about amidst the pebbles, searching for their prey which includes various aquatic larvae. They prefer quiet or slow-moving water along the edges of streams, but may swim out into deeper water where the current is swift.

Eggs are glued to the surface of pebbles. They are laid by overwintering females during the spring and early summer. They are suboval in form with a small buttonlike micropyle at the anterior end. When first laid they are creamy white in color. After about a week the color changes to gray and reddish eye spots can be seen

th igh the chorion as development progresses. Hatching occurred within 47 to 52 days at Berkeley where it is cool during April, May and June and within 25 to 33 days at Davis where temperatures are much higher. Hatching occurs by bursting a crescent shaped tear at the micropylar end of the egg. An embryonic membrane is cast in the process of emergence from the egg.

The length of nymphal instars was determined in the laboratory at Davis during May, June, and July. Average figures are given. First instar 13 days, second 12 days, third 14 days, fourth 15 days, and fifth 22 days. The various stages in the life history are illustrated in Plate X.

Ambrysus pulchellus Montandon

The typical form of this species was collected in great numbers at Tejupileco, Temascaltepec, Mexico. It is a very dark species with subparallel sides and with a few punctures near the antero-lateral angles of the pronotum and a few very superficial wrinkles anteriorly at center of disk in some specimens as noted by Champion. Other specimens have the above characters more pronounced and break down at least those characters used by Montandon in his key to separate this species from *nitidulus*. Since my series is from much nearer the type locality of *nitidulus* (Guadalajara) than the type locality of *pulchellus* (Guatemala), an examination of the type of *nitidulus* in the light of present knowledge may synonymize the latter species.

Somewhat smaller and paler examples of *pulchellus* are at hand from Cochise county, Arizona, July 29, 1927, R. H. Beamer collector.

Ambrysus pallidulus Montandon

Described as a variety of *pulchellus* by Montandon. In a fine series which must belong here, taken by J. O. Martin at Roosevelt, Texas, April 21, 1924, the color varies but the dilation of the embolium is distinctive so that it would seem to be a good species.

Ambrysus pudicus Stål

This species has been recorded from a wide area including most of the southwestern United States and Mexico. However, I have never seen a determined specimen in any collection which rightfully belongs here and have only been able to place the species by sending a number of doubtfully related forms to Dr. Lundblad for comparison with Stål's type. One of these specimens proved to be "the real *pudicus* and to agree fairly well with the type." (Lundblad, *in litt.*)

Dr. Hinton and I took a series of this species at Tejupilco. In my specimens the interocular space is scarcely, if at all, wider behind than the length of the head. I know it only from Mexico.

Ambrysus infuscatus Usinger, n. sp.

Form broadly suboval, slightly attenuated posteriorly. Head very small, much less than half the width of pronotum behind, 24::56, the interocular space narrower behind than length of head, 13::17, its sides subparallel, narrower anteriorly; disk impunctate except for a row of punctures along the inner margin of each eye. Labrum rounded apically. Eyes moderately convex. Pronotum strongly transverse, over three times as broad as long on median line, the sides strongly dilated, antero-lateral angles very nearly right angles, lateral margins distinctly carinate, with long, depressed, medially directed, submarginal hairs; postero-lateral angles subrounded; disk smooth, polished and impunctate except for a few scattered punctures laterally, rather evenly, moderately convex. Embolium smooth and impunctate except on inner apical third which is shagreened, with a deep longitudinal impression on inner basal half, the margin carinate with long depressed submarginal medially directed hairs, the margin subrectilinear at middle, strongly rounded subapically. Connexivum rather broadly exposed, the posterior angles of segments produced into acute spines. Venter broadly, longitudinally elevated at middle, the first two segments carinate. Posterior margins of metasterna produced into subrounded lobes. Anterior femora less than two-thirds as broad as long, 13::22.

Color fulvous with obscure darker brownish marks on head and pronotum, scutellum and hemelytra infuscated, the basal and outer two-thirds of embolium fulvous, corium sublaterally beyond embolium somewhat paler and membrane black. Bases of connexival segments darker, eyes brown to black and with characteristic markings of thoracic pleura and sterna black.

Size: Male, length, 8.6 mm.; width, 5.5 mm. Female, length, 8.8 mm.; width, 5.8 mm.

Holotype, male, and allotype, female (California Academy of Sciences), Tejupilco, District of Temascaltepec, Mexico, June 15, 1933, H. E. Hinton and R. L. Usinger collectors. Three female paratypes, same data as the type.

Very close to *parviceps* Montd. and will run to that species in Montandon's key but uniformly darker, fulvous, the membrane black, concolorous, anterior margin of pronotum at middle not de-

pressed, the interocular space subdepressed between moderately elevated eyes (eyes flattened in *parviceps*) and the sides of interocular space more nearly parallel. First two abdominal segments beneath with subprominent, carinate tubercles at middle.

Ambrysus barberi Usinger, n. sp.

Oblong oval. Head slightly narrower, eyes included, than half width of pronotum behind, 27::58; interocular space narrower behind than length of head, 15::17.5, rather evenly narrowed apically, 15::11, the inner margins of eyes scarcely concave; disk impunctate except for a row of punctures along inner margin of each eye. Labrum twice as broad as long, subrounded. Pronotum longer than head on median line, 20::17.5, almost three times as broad behind as long, 58::20. Antero-lateral angles scarcely more than right angles, lateral margins but feebly arcuate, the postero-lateral angles abruptly subtruncate; disk moderately, evenly elevated, impunctate, with fine transverse wrinkles anteriorly at center; laterally near the margins with a few large, ill-defined punctures. Embolia only moderately dilated, width, at this point, not so much greater than posterior width of pronotum, 67::58. Membrane reaching tip of abdomen and thus obscuring progressively more of connexivum apically. Connexivum rather broadly exposed, posterior angles of its segments sharp, but little produced, following well the curve of the abdomen. Posterior margin of metasternum roundly emarginate over posterior coxae, subangulately produced laterally. Front femora less than two-thirds as broad as long.

Color testaceous, the eyes black, markings of head and pronotum brown to black, the sides of scutellum, commissure of clavus, corium at inner apex of embolium and at middle of apical margin paler and basal $\frac{3}{4}$ of embolia yellow. Connexivum yellow, infuscated at the sutures. Beneath in great part yellow to light brown, the prosternum posteriorly, mesosternum and metasternum anteriorly darker. Legs tinged with green.

Size: Male, length, 8.58 mm.; width (embolia), 5.58 mm. Female, length, 9.16 mm.; width, 6.08 mm.

Holotype, male, and allotype, female (U. S. National Museum) Victoria, Tampico, Mexico, December 10, 1909, F. C. Bishopp collector. Two female paratypes, same data as type. I am pleased to dedicate this species to Mr. H. G. Barber to whom I am indebted for many kindnesses during the past few years.

Closest to *pudicus* Stål but considerably larger with the inter-

ocular space narrower behind than length of head and the head width, eyes included, only slightly less than half the width of pronotum behind, 27::58. In the remaining members of the group with polished pronotum and impunctate disk, *parvicaps* Montd. has a much smaller head and broader pronotum with its sides more strongly arcuate and *nitidulus* Montd. and *pulchellus* Montd. have a much larger head and the pronotum strongly narrowed behind.

Ambrysus caliginosus Utinger, n. sp.

Fern compact oval, rather strongly convex above. Head a little longer than width of interocular space behind, 18::15, its greatest width, eyes included, one-half the greatest width of pronotum. Inner margins of eyes converging in front on all their length, subrectilinear. Anterior margin distinctly surpassing level of anterior angles of eyes, strongly rounded laterally, subrectilinear at middle. Disk rather evenly and densely punctate throughout except narrowly on anterior margin which is faintly rugose. Labrum transverse, rounded apically. Subgenal plates scarcely produced, just visible from above. Pronotum subequal in length to head on median line, the disk subflattened at middle, evenly, rather finely punctate throughout, the transverse impression distinct but not very deep. Antero-lateral angles feebly produced, sharp, sides straight anteriorly, broadly rounded posteriorly and then very briefly, obliquely truncate at postero-lateral angles, the sides of pronotum minutely crenulate. Scutellum shagreened as on the hemelytra. Hemelytra scarcely attaining apex of abdomen, exposing a broad portion of connexivum on either side; emboliar margin abruptly but roundly angled anteriorly, then feebly arcuate to posterior third where it is more strongly rounded and then distinctly concavely sinuate at apex. Connexival angles scarcely produced, little more than right angles except on the last segment where they are distinctly, angulately produced. Prosternum moderately depressed and noncarinate posteriorly, the propleura closely appressed to prosternum where they meet over it.

Color rather dull brown to black, the apical two-thirds of head, broad marginal areas of pronotum, basal two-thirds of embolia, commissure of clavus, a small spot at middle of apical margin of each corium and posterior portions of connexival segments somewhat paler, fuscotestaceous to testaceous. Extreme ledged margins of pronotum and embolia dark brown. Scutellum except at angles and remaining portions of hemelytra black.

Size: Length, 8.7-9.3 mm.; width, 4.8-5.1 mm.

Holotype, male, and allotype, female (California Academy of Sciences) Tejupileo, District of Temascaltepec, Mexico, June 18-21, 1933, H. E. Hinton and R. L. Usinger. A series of paratypes taken at the same time and place as the holotype and allotype. This species was always taken in swift riffles of pebble-bottomed streams about Tejupileo.

Allied to *geayi* Montd. and *obscuratus* Montd. but differs from the former in the nonacuminate connexival angles and from the latter in the minutely crenulate pronotal margins.

Ambrysus fossatus Usinger, n. sp.

Elongate oval, dull. Head longer than width of interocular space behind, 24::20, less than half as wide, eyes included, as width of pronotum behind, 34::77, subequal in length to pronotum on median line. Inner margins of eyes subparallel posteriorly, moderately converging anteriorly, proportion of anterior to posterior interocular widths, 14::20. Anterior margin distinctly, arcuately produced before eyes. Disk with coarse scattered punctures on middle of basal half, densely and finely punctate in the shallow depressions along inner margins of eyes. Elsewhere almost impunctate, with a very few irregular and very obscure fine punctures. Labrum twice as broad as long, subtriangular, the apex rounded. Pronotum only feebly convex, subflattened and even a little depressed anteriorly on either side of center of disk. Disk coarsely punctate throughout, more finely so behind the rather ill-defined transverse impression. Antero-lateral angles but little produced, blunt, sides feebly arcuate, finely and very inconspicuously crenulate, the postero-lateral angles briefly, obliquely truncate, the posterior margin of pronotum feebly roundly produced over bases of hemelytra. Disk of scutellum very densely punctate with scattered granules intermixed. Hemelytra not quite reaching apex of abdomen, exposing a wide area of connexivum on either side. Embolium only feebly dilated, its margin more strongly arcuate on posterior half than anteriorly where it is subrectilinear. With a very deep fossa extending from base to beyond middle, widening and decreasing in depth posteriorly. Last 3 connexival angles very strongly produced, acuminate, the margins very faintly crenulate, except subapically on last segment where there are a few small but distinct teeth. Prosternum sharply carinate anteriorly, abruptly depressed posteriorly with the carina persisting as an elevated line; the propleural plates not closely appressed to sternum where they meet above it.

Color fulvous, somewhat paler on front legs and prostethium with the pronotum testaceous behind the transverse impression. Labrum, scutellum and underside darker, brown. Hemelytra shagreened, dark fuscous or fusco-piceous except on outer margins of embolia. Connexivum ochraceous with the margins narrowly fuscous. Eyes black.

Size: Length, 12.9-13 mm.; width, 7.1-7.2 mm.

Holotype, female (Snow Museum, University of Kansas) Tena., Vicinity of Oriente, Ecuador, March 29, 1923, collected by F. X. Williams in a wide, rather shallow and exposed stream of running water at an elevation of 1,800 feet. Allotype, male, and one male and four female paratypes, same data as holotype.

Allied to *peruvianus* Montd. but considerably larger and with the antero-lateral angles of pronotum only feebly produced, blunt, with a very deep fossa occupying more than half of the basal portion of the embolium at middle.

Ambrysus hungerfordi Usinger, n. sp.

A small suboval species with punctate pronotum. Suboval in form but slightly attenuated posteriorly, surface polished. Head rather small, transverse, 23::15.5, slightly less than half the width of pronotum at base; interocular space twice as broad at base as width of an eye, regularly narrowed anteriorly, 12::9, and longer than broad at base, 15.5::12, with a distinct fovea at anterior corner of each eye and a slightly depressed row of punctures along the inner margin of each eye as well as a few scattered punctures medially near base. Labrum almost twice as broad as long, evenly rounded. Pronotum only moderately elevated, strongly transverse, being three times as broad as long on median line; anterior margin typically trisinate, subtransverse behind the eyes; antero-lateral angles a little less than right angles; lateral margins evenly arcuate, the postero-lateral angles abruptly rounded, disk distinctly punctate, even behind the moderately well-defined transverse impression, conspicuously wrinkled at middle. Scutellum over twice as broad as long, 32::14, the sides feebly sinuate, surface shagreened. Hemelytra excepting embolia anteriorly and laterally shagreened, the membrane clearly distinguishable from the corium. Embolium strongly expanded, coarsely and irregularly punctate anteriorly and laterally; width across embolia greater than width of pronotum behind, 57::49.5; lateral margin of corium evenly arcuate, forming a concave angle adjoining with corial margin which thenceforth fol-

lows an evenly, lightly rounded course exposing an ever decreasing connexival margin to apex but does not cover tip of genital segment. Postero-lateral angles of connexival segments produced into short, acute spines which follow well the curve of the abdomen. Beneath rather densely, finely pilose; posterior margins of metastethia deeply, roundly emarginate over coxae, then prolonged into long rounded lobes from whence they are obliquely rectilinear to lateral margins. Front femora over half as broad as long, 12::19.

Color flavous on the head, pronotum and basal two-thirds of embolium with brown markings characteristic of the genus on the head. Eyes black. Rostrum fuscous. Pronotum with two brown spots anteriorly at middle, an obscure arcuate series of brown to black punctures behind each eye directed toward postero-lateral angles, and various scattered brown spots covering the disk behind the anterior flavous region. The latter extends backward for a considerable distance either side of the middle, before the testaceous to luteous band and within in the broad immaculate lateral areas. Elsewhere dark brown to black, the scutellum paler at center, along lateral margins and at apex; clavus narrowly flavous at base with an obsolete pale area medially at basal third, its commissure pale at apex; corium obscurely mottled with fusco-testaceous or tinged with olivaceous, appearing decidedly paler beyond apex of embolium within the lateral margin to membrane. Connexivum testaceous, with fuscous at inner basal region of each segment. Beneath in great part fuscous to testaceous, dark brown to black anteriorly on prostethium, posteriorly on prosternum scarcely reaching lateral margins, on the mesosternum but not at all reaching the lateral margins and on the metasternum excepting the flavous posterior lobes, reaching the lateral margins. The base of each abdominal segment laterally is black and the venter is inclined to be fulvous toward the middle. Legs testaceous to green, the tarsi black apically.

Size: Male, length, 7.08 mm.; width (embolium), 4.75 mm. Female, length, 7.92 mm.; width, 5.5 mm.

Holotype, male, and allotype, female (Snow Museum, University of Kansas) San Antonio, Mexico, July 15, 1927, R. H. Beamer. A series of paratypes collected at the same place by both R. H. Beamer and P. A. Readio.

In addition to the topotypic series of 62 specimens, the following specimens exhibiting more or less variation in extent and intensity of color are before me: 24 specimens, Rio Mayo, Arroyo, San Bernardo, Sonora, Mexico, March 6, 1935, H. S. Gentry; 1 spec. Nova-

joa, Sonora, Mexico, March 5, 1930, Doris Wright; 1 spec. Agua Caliente, Lower Calif., Mexico, July 24, 1919, J. R. Slevin; 6 specimens, Tejupilco, District of Temascaltepec, Mexico, July 13, 1932, H. E. Hinton; and a series of several hundred specimens taken by myself at Tejupilco during June and July, 1933.

Hungerfordi is not closely related to any previously described species. It will run to *californicus* in Montandon's key but *californicus* is yellowish to luteous in color and much more elongate with a narrower pronotum. *Hungerfordi* approaches *pubicus* which, however, has a "shining and nearly impunctate pronotum the margins of which are nearly straight." It is a pleasure to dedicate this distinctive species to Dr. H. B. Hungerford.

Ambrysus woodburyi Usinger, n. sp.

Male. Form suboval, slightly attenuated behind, the surface polished, especially on head and pronotum. Head broader, eyes included, than half the width of pronotum behind, 27::50; two-thirds as long as wide; interocular space almost as broad behind as length of head, 17::18, much narrowed anteriorly, 17::12, the inner margins of eyes roundly converging apically; disk punctate throughout, the punctures rather sparse and ill-defined anteriorly. Labrum twice as broad as long, rounded but slightly more produced than a semicircle. Pronotum scarcely shorter than head on median line, with a broad depression behind anterior margin at middle and lighter depressions within the lateral margins; disk closely punctured throughout but especially laterally with a few rows of conspicuous wrinkles anteriorly at middle; behind transverse impression very finely punctate and minutely longitudinally rugose; antero-lateral angles sharp, a little less than right angles, lateral angles feebly rounded anteriorly, more strongly so posteriorly. Scutellum twice as broad as long, the lateral margins sinuate, surface finely punctate, almost granular. Hemelytra shagreened excepting the outer anterior two-thirds of embolia which are roughly indistinctly punctate. Emboliar margin moderately rounded, forming a slightly concave angle at apical junction with corial margin. Connexivum moderately exposed, particularly at middle, the hemelytra equalling tip of abdomen. Posterior angles of connexival segments produced into short sharp angles but not conspicuous. Posterior margin of metasternum distinctly emarginate over the posterior coxae, produced into a short subangular lobe. Front femora two-thirds as broad as long.

Color fulvous, somewhat paler, testaceous on the interocular space excepting basally and medially where the characteristic brown markings are conspicuous. Pronotum paler laterally and just behind distinct transverse impression, with conspicuous brown spots except on the subtriangular central area. Basal two-thirds of embolium and connexival segments, except for fuscous bases, appendages and under side of head, testaceous. Eyes black, hemelytra excepting as above, fuscous to black. Under side in great part brown.

Female larger and considerably paler, the tip of commissure of clavus, inner anterior angle and anterior margin at middle of corium testaceous.

Size: Male, length, 7.83 mm.; width (embolium), 5 mm. Female, length, 8.83 mm.; width (hemelytra slightly expanded), 6.33 mm.

Holotype, male, and allotype, female (California Academy of Sciences) Zion National Park, Utah, A. M. Woodbury collector. Two paratypes, same data as type. One paratype same locality as type, Sept., 1925; one, same but July 9, 1927, R. V. C.; one Moab, Utah, W. S. Gertsch; and one, Sunnyside, Nevada, C. T. Brues Hot Springs Expedition, 1930, species number 94. I collected an additional series of specimens in the run-off from a small spring a few feet from the banks of the Virgin river in Zion Canyon, Utah, June, 1941.

The paratypes exhibit unusual variation in size and coloration, one topotypic female being only 7.08 mm. long and 4.4 mm broad and having entirely dark brown to black hemelytra excepting on basal two-thirds of embolium. Another frequent variation from the above description is a marginal black band on the connexiva.

Three specimens are at hand from Cave creek, Cochise county, Arizona, June 20, 1929, J. O. Martin collector, which differ only slightly from the type. In these the head is slightly narrower, being subequal or slightly narrower than half the width of pronotum behind. The pronotum is feebly depressed either side of the middle. The connexival angles are scarcely acute, the hemelytra are dark brown to black and the membrane exceeds the tip of the abdomen.

Allied to *hungerfordi* but easily distinguished by the depressed median pronotal region and more generally punctate head.

Ambrysus bohartorum Usinger, n. sp.

Head one-half as broad, eyes included, as width of pronotum behind, two-thirds as long as wide; interocular space narrower behind than length of head, 17::20; inner margins of eyes subparallel on

basal half, then convergent to apex which is much narrower than base, 13::17; surface impunctate anteriorly with a transverse fovea near apex of each eye; irregularly, inconspicuously punctate basally and laterally. Labrum twice as broad as long, rounded. Pronotum as long on median line as width of interocular space behind; three and one-half times as broad as long, 59::17, the lateral margins broadly rounded; disk subdepressed within the lateral margins, strongly depressed laterally along distinct transverse impression; antero-lateral angles almost right angles; surface distinctly but irregularly punctate, more closely so laterally, transversely wrinkled anteriorly at center. Embolia rather strongly dilated, width at this point one-fifth greater than pronotum behind. Connexivum broadly exposed, posterior angles of segments strongly produced, those of the fifth segment blunt. Posterior margin of metasternum emarginate over posterior coxa, moderately produced and subrounded laterally and thence obliquely and slightly sinuately continued to margin. Anterior femora a little less than two-thirds as broad as long.

Color green laterally, the eyes black, characteristic markings of head, hemelytra excepting basal two-thirds of embolium and a minute pale spot at center of apical margin of corium and bases of connexival segments dark brown to black. Scutellum lighter brown, irregularly mottled, with testaceous basal angles and with black spots on base one-fifth of the total width from each lateral angle. Pronotum with very ill-defined fuscous marks in the central area not forming any pattern other than the characteristic one. Beneath in great part brown, the appendages green.

Size: Length, 9.16 mm.; width, 6.16 mm.

Holotype, female. (California Academy of Sciences) Austin creek, near Cazadero, Sonoma county, California, April 30, 1935, R. M. and G. E. Bohart collectors. Four paratypes, same data as the type.

Near *californicus* Montandon but suboval in form, the pronotum much broader and embolia more strongly dilated. Posterior angles of connexival segments except the last segment prolonged into long, acute spines slightly suggestive of small examples of *mormon* Montd. However, *mormon* is more elongate with the pronotum proportionately much narrower and with characteristic longitudinal markings which are wanting in *bohartorum*.

Ambrysus convexus Usinger, n. sp.

Elongate-oval, moderately convex, very densely, distinctly punctate above. Head transverse, 30::19, a little longer than width of interocular space behind, 19::17, the inner margins of eyes converg-

ing anteriorly on all their length but subparallel on basal half, ratio of interocular width at base and apex, 18::14; disk densely punctate except at extreme apical margin. Labrum twice as broad as long, rounded apically. Pronotum three times as broad at base as long on median line and equal in length to head; antero-lateral angles a little more acute than right angles but not sharp; sides strongly divergent, evenly feebly arcuate to postero-lateral angles which are broadly rounded and then feebly emarginate before base of corial margin; disk quite strongly elevated; sides uniformly, densely punctate throughout their length, disk distinctly wrinkled anteriorly at middle. Scutellum twice as broad as long, moderately convex. Hemelytra reaching just to apex of abdomen, commissure of clavus little more than half as long as scutellum; embolium moderately dilated, abruptly rounded at base, with sides regularly arcuate to apical fourth where they are more strongly rounded and convergent to point of joining with corium where a very feeble, concave angle is formed. Connexivum rather evenly exposed at least on second, third and fourth segments, the postero-lateral angles not acute, little more than right angles, except on fourth and fifth segments. Beneath with the venter rather strongly tumid longitudinally at middle, the first two segments feebly carinate. Front femora almost two-thirds as broad as long.

Color testaceous with markings of head and pronotum conspicuously fuscous. Scutellum dark fuscous except for pale apex. Hemelytra largely pale fusco-testaceous, the claval commissure, three obscure longitudinal marks from apex of embolium to apex of corium one of which is marginal, apical third of embolium and membrane darker, fusco-ferrugineous to almost black; a pale spot at middle of apical margin of corium. Eyes and inner bases of connexival segments black. Beneath in great part dark brown to black anteriorly, lighter brown posteriorly, the margins, underside of head, prosternal carina and appendages ochraceous to fulvous.

Size: Male, length, 8.75 mm.; width (embolium), 5.58 mm. Female, length, 9.58 mm.; width (embolium), 6 mm.

Holotype, male and allotype, female (California Academy of Sciences) Real de Arriba, District of Temascaltepec, Mexico, May 25, 1933, H. E. Hinton and R. L. Usinger. A long series of paratypes, same data as the type.

This was the commonest Naucorid at Real de Arriba and ranged from 6,000 ft. up to "LaCumbre" at 9,000 ft. where it was found in a small stream less than a foot in width and only two inches in depth, flowing through a meadow.

Ambrysus convexus, n. sp., is related to *dilatus* Montd. but is smaller, darker in color, with the postero-lateral angles of the pronotum rather broadly rounded and the embolium more dilated. From *hybrida* Montd. it may be distinguished by its smaller eyes, the longer head which exceeds the width of interocular space behind, and which, together with pronotal length on median line, is much more than half the width of pronotum behind. It is much broader than *mexicanus* Montd. in which the pronotum is only two and one-half times as broad as long and the embolia are but little dilated.

Ambrysus fuscus Usinger, n. sp.

Oval in form, more narrowed posteriorly than anteriorly. Head transverse, 31:21, slightly longer than width of interocular space behind, one-half as broad as pronotum behind and scarcely longer than pronotum on median line; inner margins of eyes subparallel posteriorly, distinctly converging anteriorly, ratio of posterior to anterior width of interocular space 18:14; disk elevated at center, broadly depressed on either side near the eyes, the surface distinctly punctate except on extreme anterior margin. Labrum almost twice as broad as long, evenly rounded. Pronotum three times as broad as long, the disk strongly elevated within depressed lateral borders, with a distinct depression before the anterior margin at middle; disk densely coarsely punctured except behind transverse impressions where the punctures are somewhat finer; coarsely wrinkled along entire median depression; antero-lateral angles slightly more than right angles but not sharp; sides evenly arcuate and strongly divergent to postero-lateral angles which are suddenly rounded, minutely emarginate and thence feebly arcuate on posterior margin before base of clavus. Scutellum twice as broad as long, the sides scarcely sinuate, with a distinct transverse subbasal impression. Hemelytra almost or quite attaining apex of abdomen. Emboliar margin strongly, rather evenly arcuate, a little more strongly converging at edge of connexivum, forming a distinct concave angle with corial margin. Claval commissure one-half as long as scutellum. Connexivum moderately exposed. Postero-lateral angles little more than right angles, scarcely produced. Front femora three-fifths as broad as long.

Color fuscous, the interspaces between markings of head and pronotum and extreme anterior and lateral margins and posterior margin behind transverse impression of pronotum, basal three-fourths of embolia, angles of scutellum and connexival segments except at inner bases paler, fusco-testaceous to testaceous. A number of very dis-

tinct small round plates forming the brown pattern on elevated disk of pronotum. Elsewhere on scutellum and hemelytra dark brown to black. Beneath in great part, smoky dark brown to black, the legs somewhat paler.

Female distinctly more rounded in general outline than male, broader at emboliar level.

Size: Male, length, 9.25 mm.; width (embolium), 5.59 mm. Female, length 10.84 mm.; width (embolium), 6.5 mm.

Holotype, male, and allotype, female (California Academy of Sciences) Real de Arriba, District of Temascaltepec, Mexico, July 10, 1933, H. E. Hinton and R. L. Usinger. Thirteen paratypes, between June 24 and July 10, 1933, same locality as the type.

These bugs were not at all abundant. They were found very rarely in company with *Ambrysus convexus* and more commonly in the flume which supplies water to the Rincon Mine just above Real de Arriba.

A very distinct species related to *convexus* n. sp., *dilatatus* Montd., and *hybrida* Montd. but differing from all of these in its darker coloration with concolorous corium and its broader pronotum and more strongly dilated embolia.

Ambrysus bucnoi Usinger, n. sp.

Very evenly oblong-oval. Head transverse, 28.5::19, longer than width of interocular space behind, the ratio of interocular widths posteriorly and anteriorly, 17::12, the inner margins of eyes subparallel on basal half and strongly convergent on apical half; interocular space but little elevated at middle, slightly depressed near the eyes, the disk irregularly finely punctate except on anterior margin. Labrum strongly transverse, 8::3, rounded apically. Pronotum as long as head on median line, twice as broad as head including eyes; rather evenly convex throughout, the disk irregularly punctured throughout and coarsely wrinkled anteriorly at middle; antero-lateral angles rather sharp, sides evenly arcuate, moderately dilated posteriorly; postero-lateral angles abruptly rounded, minutely emarginate; posterior margin almost imperceptibly arcuate before base of clavus. Scutellum almost twice as broad as long with a sinuate transverse impression sub-basally; sides feebly sinuate; apex subacute. Hemelytra not quite reaching tip of abdomen; embolium only moderately dilated, its sides feebly arcuate except at extreme base and apical fourth, forming a small but distinct concave angle at junction with corial margin, less than one-third as

wide posteriorly as long, 9::31. Commissure of clavus approximately one-half as long as scutellum. Connexivum broadly exposed, postero-lateral angles of second, third and fourth segments, moderately acutely produced. Front femora about three-fourths as broad as long.

Color obscure fulvous to testaceous, the markings of head and pronotum ill-defined, brown, the transverse impression fairly distinct, behind which the pronotum is testaceous. Scutellum reddish brown, paler at the angles. Hemelytra generally infuscated with numerous ill-defined paler spots on the clavus and corium, especially at inner apex of embolium and middle of apical corial margin. Embolium pale on basal three-fourths, membrane mottled, fusco-testaceous to darker. Connexivum yellow with segments darker basally or submarginally. Eyes dark. Under side of body generally brown but paler laterally on abdominal segments with the legs fulvous.

Size: Male, length, 8.92 mm.; width (embolium), 5.25 mm. Female, length, 10.17 mm.; width (embolium), 6.17 mm.

Holotype, male (U. S. National Museum) Rio Grande, Brewster Co., Texas, June 13-17, 1908, Mitchell and Cushman collectors. Allotype, female, and a male and female paratype, same data as type. There is also a female specimen from Neville Springs, Texas, Geo. M. Green collection, which may belong here although it differs in having a less strongly transverse labrum and in several other particulars. Likewise a female from the same series as the type is considerably darker in color and broader posteriorly.

The type bears an identification label "*Ambrysus mexicanus* Montd., Det. J. R. de la T. Bueno," and it gives me great pleasure to dedicate this species to Mr. Bueno. *Buenoi* is perhaps closest to *mexicanus* but with the pronotum three times as broad as long, the head slightly longer than broad between the eyes in back, and the connexival angles very shortly but acutely produced.

Ambrysus variegatus Usinger, n. sp.

Elongate oval, the head broad, pronotal margins feebly arcuate, not strongly dilated posteriorly, connexival segments with angles sharp but scarcely produced.

Head strongly transverse, 41::26, only slightly longer than width of interocular space behind, 26::24, the interocular space with sides subparallel on posterior two-thirds, converging anteriorly, the ratio of posterior to anterior width, 24::19; disk but little elevated, depressed on either side near inner margins of eyes, where it is more

coarsely punctate than elsewhere. Labrum twice as broad as long, evenly rounded anteriorly. Pronotum almost twice as broad posteriorly as width of head including eyes, 79:41; longer than head on median line, 30:26; and distinctly less than three times as broad as long; antero-lateral angles much less than a right angle but only subacute, extending beyond level of middle of eyes; sides feebly sinuate anteriorly, then slightly arcuate to postero-lateral angles which are suddenly rounded and then minutely emarginate before straight posterior margin; disk rather strongly, evenly convex, punctate throughout and anteriorly transversely wrinkled at middle. Scutellum a little more than twice as broad as long, moderately, evenly elevated. Hemelytra not quite attaining tip of abdomen, commissure of clavus two-thirds as long as scutellum; emboliar margin moderately, evenly dilated, three and one-half times as long as greatest width, forming a slightly concave angle at junction with corial margin. Connexivum with angles little more than right angles, scarcely produced. Front femora a little less than two-thirds as broad as long.

Color yellow, the markings of head and pronotum distinct, brown, the scutellum dark fuscous except at angles and longitudinally along middle. Hemelytra fuscous to black with clavus yellow transversely at base, along sutures, commissure and broadly at middle; the embolium yellow on basal two-thirds; corium with an obscure pale spot near inner apical angle of embolium and an elongate spot at middle of apical margin, these spots on either side anteriorly divergent. The corium may be paler submarginally and near the clavus. Membrane small, black. Connexivum yellow, fuscous at the base of each segment within clear margin. Beneath in great part yellow the venter fulvous margined with fuscous.

Size: Male, length, 12.84 mm.; width (embolium), 7.25 mm. Female, length, 13.4 mm.; width (embolium), 7.9 mm.

Holotype, male (California Academy of Sciences) West of Cartago, Costa Rica, C. A., 4,700 ft., June 10, 1932, B. S. Kaiser. Allotype, female, (California Academy of Sciences) near Santa Maria Dota, Costa Rica, C. A., 5,000 ft., June 23, 1932, B. S. Kaiser. Paratypes, 16 specimens from West or South of Cartago, near Santa Maria Dota, and near Tajar, Costa Rica, June 10-23, 1932, B. S. Kaiser, and 4 specimens, San Jose, Costa Rica, June and July, 1931, Heinrich Schmidt, from Dr. H. B. Hungerford.

Near *bergi* Montd. but with the antero-lateral angles not so conspicuously sharp, the length of head and pronotum together much

greater than half the width of pronotum behind, 55::40. The hemelytral margin shallowly, angulately sinuate at apex of embolium. *Variegatus* is superficially very similar to *guttatipennis* Stål in which, however, the head is obviously smaller, less than half the width of pronotum behind, the embolium strongly rounded at base, and the general form slightly broader.

I have a series of 8 specimens from Mexico which average smaller in size with the head as broad or broader than in the Costa Rica specimens and with the pronotal margins more nearly parallel. I have not assigned a name to this Mexican series because all of the characters break down when compared with the variable Costa Rica series.

Ambrysus sonorensis Usinger, n. sp.

Oval, widest a little behind middle. Embolia strongly rounded posteriorly, connexival angles strongly produced, sharp. Connexival margins finely serrate. Color very dark, the markings black, the under side yellowish with the legs highly polished.

Head broad, 47::29, the interocular space almost as broad behind as length of head, 28::29, strongly narrowed anteriorly, particularly on anterior half, ratio of posterior to anterior widths, 28::22; disk irregularly punctate throughout, more strongly so in the submarginal depressions which are slightly convergent posteriorly, thus parting from the inner margins of eyes toward the base of head. Labrum twice as broad as long. Pronotum almost twice as broad posteriorly as width of head, 92::47, a little more than two and one-half times as broad as long, 92::35, considerably longer than head on median line, 35::29; antero-lateral angles a little less than right angles, sharp; sides narrowly carinate, feebly arcuate; postero-lateral angles subtruncate, the posterior margin straight or almost imperceptibly arcuate; disk strongly elevated, subdepressed at middle and laterally before margins; surface punctate throughout, transversely wrinkled anteriorly at middle, rugosely punctate on depressed sides; transverse impression very superficial. Scutellum over twice as broad as long, its sides wrinkled transversely to the direction of the margins. Hemelytra attaining tip of abdomen; commissure of clavus two-thirds as long as scutellum; embolium moderately strongly dilated, three times as long as greatest width, its margin rather evenly rounded at middle, more strongly so narrowly at base and on posterior fourth, margin feebly sinuate at apex of embolium. Connexivum with postero-

lateral angles acutely produced, margins finely evenly serrate. Front femora two-thirds as broad as long.

Color mostly black above, the head paler, ochraceous to fulvous except for characteristic brown markings and an anteriorly widening marking with pale center on either side of central longitudinal markings, as well as two semicircular markings anterior to these, black. Labrum pale on basal half. Rostrum black. Pronotum with characteristic markings of the genus very prominent, conspicuously yellow at center and on lateral margins posteriorly. Testaceous just behind black transverse impression but dark brown along entire posterior margin. Sides narrowly ferrugineous. Scutellum with pale margins and angles as well as a longitudinal line at middle. Hemelytra with ill-defined light brown spots on coria near inner posterior angles of embolia, basal two-thirds of embolia yellow. Connexivum brown, black at the sutures, and yellowish near corial margin. Beneath in great part yellow to fulvous, the legs highly polished and curiously variegately streaked with black, brown, gray, and yellow.

Size: Male, length, 13.2 mm.; width (embolia), 9 mm.

Holotype, male, (California Academy of Sciences) San Bernardo, Rio Mayo, State of Sonora, Mexico, March 2, 1935, H. S. Gentry collector.

This species is not to be confused with any species known to me. It belongs to the *signoreti* group but differs from all of its relatives in color and in the serrate connexival margins.

Ambrysus lunatus Usinger, n. sp.

Elongate, oval, widest behind middle and rather strongly narrowed anteriorly. Embolia strongly dilated, connexival angles strongly, acutely produced. Color pattern distinct, the coria each with a conspicuous anteriorly divergent vitta from middle of anterior margin.

Head transverse, 35::24, a little longer than width of interocular space behind, 24::21; inner margins of eyes converging both anteriorly and posteriorly, the widths posteriorly, just before middle, and at apex, 21::22::18; disk rather regularly punctate at middle, more coarsely and irregularly so in lateral subdepressed areas. Labrum a little less than twice as broad as long, subtriangular in outline, the apex rounded. Pronotum a little less than twice as broad as head including eyes, three times as broad as long and subequal in length to head on median line. Antero-lateral angles a little less than right

angles, subacute; sides feebly arcuate, the postero-lateral angles abruptly rounded; disk moderately elevated, slightly depressed behind eyes and anteriorly at middle where it is strongly transversely wrinkled; transverse impression sinuate either side of the middle; surface conspicuously punctate throughout. Scutellum twice as broad as long, its sides sinuate, apex subacute, commissure of clavus two-thirds the length of scutellum. Hemelytra almost attaining tip of abdomen; embolium strongly dilated, especially at base and on posterior two-thirds, three times as long as broad, its margin scarcely concavely angled at junction with corial margin. Connexivum with postero-lateral angles strongly posteriorly produced, acute. Front femora a little less than two-thirds as broad as long, 19::31.

Color yellowish testaceous, the characteristic markings of head and pronotum distinct, brown as is the scutellum at middle. Hemelytra fuscous, the corium with a broad testaceous spot near inner apex of embolium projecting inwardly and anteriorly and with anteriorly divergent vittae from middle of apical margins of coria not quite touching the median spots. Elsewhere with inner apical angles of coria, the commissure of the clavus and the claval bases as well as along inner margin and broadly at middle of clavus pale. Embolia yellow on basal two-thirds. Membrane almost black with an obscure pale mottled area near middle. Connexivum yellow, the bases of segments black. Beneath generally yellow, the venter fulvous, the apices of tibiae brown and tip of rostrum black. Eyes silvery black.

Size: Male, length, 10.84 mm.; width (embolia), 7 mm. Female, length, 12 mm.; width (embolia), 7.42 mm.

Holotype, male, and allotype, female (Snow Museum, University of Kansas) Tom Greene county, Texas, July 15, 1928, R. H. Beamer collector. Paratypes: 4 specimens, same data as type; a long series from Eddy county, New Mexico, July 9-12, 1927, R. H. Beamer; Ft. Stockton, Texas, July 5, 1917, H. H. Knight; Kerr county, Texas, July 21, 1928, Jack Beamer; and Roosevelt, Texas, April 21, 1924, J. O. Martin collector.

In the series of paratypes, the Ft. Stockton series in particular is very much paler than the others. In some cases a submarginal pale area extends posteriorly from the apical margin of the embolium, adding to the distinctive coloration of this species. Also the brown discal spot of scutellum may be divided longitudinally at middle.

This species is quite distinct from any species known to me. It

is perhaps closest related to *mormon* Montd. with the same narrow pronotum but differs greatly from this species in color and other characters.

Ambrysus lundbladi Usinger, n. sp.

Elongate-oval, widest slightly behind middle. Pronotum twice as broad as head including eyes. Embolium moderately strongly dilated. Connexival angles sharply produced posteriorly. Color pattern distinctive.

Head transverse, 38::24, a little longer than width of interocular space behind, 24::22; inner margins of eyes subparallel or slightly converging posteriorly on posterior two-thirds, distinctly converging anteriorly, the ratio of basal to apical width, 22::17, disk irregularly, distinctly punctate, especially on lateral subdepressed areas. Labrum twice as broad as long, apically rounded. Pronotum twice as broad as head including eyes, scarcely longer than head on median line and a little less than three times as broad as long; antero-lateral angles a little less than right angles, acute; sides moderately arcuate; postero-lateral angles abruptly rounded, the posterior margin feebly sinuate laterally, very slightly produced posteriorly over bases of clavi; disk moderately evenly convex, transversely wrinkled but scarcely depressed anteriorly at center, distinctly, irregularly punctate throughout. Scutellum twice as broad as long; disk slightly elevated, sides sinuate, the apex subacute. Hemelytra attaining tip of abdomen; commissure of clavus two-thirds as long as scutellum; embolium rather strongly dilated, the margin a little more strongly rounded at base and at level of margin of connexivum; forming a small concave angle at point of junction with corial margin; over three times as long as broad, 43::13. Connexivum broadly exposed, the postero-lateral angles of segments distinctly, posteriorly produced, acute. Front femora two-thirds as broad as long.

Color yellowish testaceous, the characteristic markings of head and pronotum distinct, brown, scutellum and hemelytra dark brown except for testaceous markings subbasally at sides, apically and longitudinally at middle of scutellum, transversely at base, on commissure, on sutures at margins and broadly at middle of clavus, on basal $\frac{3}{4}$ of embolium and corium near inner apex of embolium, at middle of apical margin, as well as laterally near margin and at inner apical angle of apical margin. The markings at middle of apical margins of coria diverge anteriorly, reaching the pale spots at inner apices of embolia, corium light brown submarginally be-

yond embolium. Connexivum ochraceous with fuscous spots at bases of segments within narrow testaceous margin. Beneath in great part yellow, the venter and legs more fulvous. Eyes black.

Size: Female, length, 12.09 mm.; width (embolia), 7.66 mm.

Holotype, female, (California Academy of Sciences) State of Morelos, Mexico, May 30, 1897. Koebele collection.

Similar in size and shape to *ochraceus* Montd. from Bolivia but with a distinct color pattern and with the posterior angles of the connexival segments moderately prolonged posteriorly, sharp. Named after Dr. O. Lundblad who kindly compared this and other *Naucorids* with types in the Naturhistoriska Riksmuseum, Stockholm.

There is a male specimen before me from the U. S. National Museum which is very much faded and badly eaten by museum pests. It bears Montandon's label "*Ambrysus ochraceus* Montd., var. 1909" and is from "Mexico."

A unique female before me from San Jose del Sacare, Chalatenango, El Salvador, C. A., March 14, 1927, R. A. Stirton, may likewise belong here although its color markings are darker, black rather than brown, its head is a little larger and the subgenital plate is a little differently shaped apically. A series of specimens will be necessary to place this correctly.

Ambrysus hintoni Usinger, n. sp.

Oblong-oval, moderately convex, the head half as broad as pronotum behind, embolium moderately dilated, connexival angles not produced.

Head transverse, 34::21, slightly longer than interocular space behind, 21::19, the interocular space subparallel on posterior two-thirds, converging anteriorly, the ratio of posterior to anterior width, 19::14; disk scarcely elevated at middle, irregularly finely punctate except for anterior impunctate margin and lateral subdepressed areas near eyes which are more densely, coarsely punctate. Labrum over twice as broad as long, rounded apically. Pronotum a little less than twice as broad as head including eyes; scarcely longer than head on median line and three times as broad as long; disk evenly elevated, scarcely depressed at middle, irregularly punctate throughout and transversely wrinkled anteriorly at middle; antero-lateral angles a little less than right angles but not sharp, sides only feebly arcuate, the postero-lateral angles abruptly rounded; posterior margin feebly sinuate laterally where it extends

very slightly posteriorly over bases of clavi. Scutellum a little more than twice as broad as long, its sides feebly sinuate, its apex subacute. Hemelytra reaching tip of abdomen; embolium moderately strongly dilated posteriorly, rather evenly arcuate beyond abruptly rounded base; a little more than three times as long as greatest width, forming a distinct concave angle at junction with corial margin; commissure of clavus two-thirds as long as scutellum. Connexivum with postero-lateral angles a little less than right angles, especially posteriorly, but not sharp. Front femora almost two-thirds as broad as long.

Color yellowish ochraceous, the characteristic markings of head and pronotum distinct, brown, the scutellum, except angles and a median longitudinal line, clavus except basally, on commissure and along sutures especially at middle, embolium on apical fifth, corium except near inner apex of embolium, middle of apical margin and more or less submarginally behind embolium, membrane and inner bases of connexival segments dark fuscous to black. Beneath in great part yellow with light brown markings on meso and metasterna and the venter brownish with the bases of the segments laterally black. Eyes black.

The female is broader posteriorly, being less narrowed along connexival margins.

Size: Male, length, 10.09 mm.; width (embolium), 6.09 mm. Female, length, 11.25 mm.; width (connexivum), 6.58 mm.

Holotype, male and allotype, female (California Academy of Sciences) Tejupilco, District of Temascaltepec, Mexico, June 30, 1933. A series of paratypes, same locality as type, June 15, 1932, and a series of paratypes, same locality as the type, June 15-20, 1933, H. E. Hinton and R. L. Usinger and one specimen, July 13, 1932, H. E. Hinton collector.

Very near *mexicanus* Montd. but with a much larger head and broader pronotum. The allotype was compared with Montandon's type and found to be different.

Ambryus vanduzeei Usinger, n. sp.

Oblong-oval with the head broad, pronotum but little dilated posteriorly, connexival segments sharply angled but scarcely produced posteriorly. Female genital plate tremendously prolonged posteriorly, extending well beyond tip of abdomen.

Head transverse, 28::19, longer than posterior width of interocular space, 19::15, its surface distinctly punctate posteriorly and

on slight depressions laterally near inner margins of eyes; ratio of posterior to anterior widths of interocular space, 15::11, the inner margins of eyes subparallel or slightly anteriorly convergent on posterior half and more strongly so anteriorly; eyes with a faint suggestion of lateral lobes. Labrum not quite twice as broad as long, rounded apically. Pronotum less than twice as broad posteriorly as head including eyes, 52::28, almost three times as broad as long and much less broad than twice length of head and pronotum together; antero-lateral angles subacute, a little more than right angles; sides only feebly arcuate, not strongly dilated posteriorly; postero-lateral angles rather abruptly, roundly angled; disk rather evenly, moderately convex, densely punctate, especially laterally, and distinctly, transversely wrinkled anteriorly at center. Scutellum twice as broad as long, its sides sinuate and its apex subacute. Commissure of clavus over one-half as long as scutellum, 11::18. Hemelytra exceeding tip of abdomen in the male, the emboliar margin rather evenly arcuate, moderately dilated, strongly roundly converging posteriorly and forming a distinct concave angle with corial margin; three times as long as greatest width, distinctly punctate laterally on basal two-thirds. Connexivum with the postero-lateral angles sharp but scarcely produced, almost right angles with a few very long hairs on margins. Beneath with the venter broadly elevated longitudinally at middle, carinate on basal two segments. Front femora three-fifths as broad as long.

Color yellowish testaceous, the characteristic markings of head and pronotum more or less distinct, brown. Scutellum brownish except for pale angles and narrowly along sides and often longitudinally at middle. Hemelytra brown with the basal two-thirds of embolium, more or less on clavus, claval commissure, and corium usually at inner angles of embolium and middle of apical margin, pale testaceous. Connexivum testaceous, more or less infuscated. Beneath rather uniformly ochraceous, the venter brownish, its margin often black. Prolongation of female genital plate fulvous. Eyes black, distinctly margined with yellow along inner sides and sometimes posteriorly as well.

Females with the sixth visible ventrite longer than broad, 20::16, its sides abruptly narrowed at basal third and extending backward one-fourth of its length beyond level of apices of pleurites, rounded at apex.

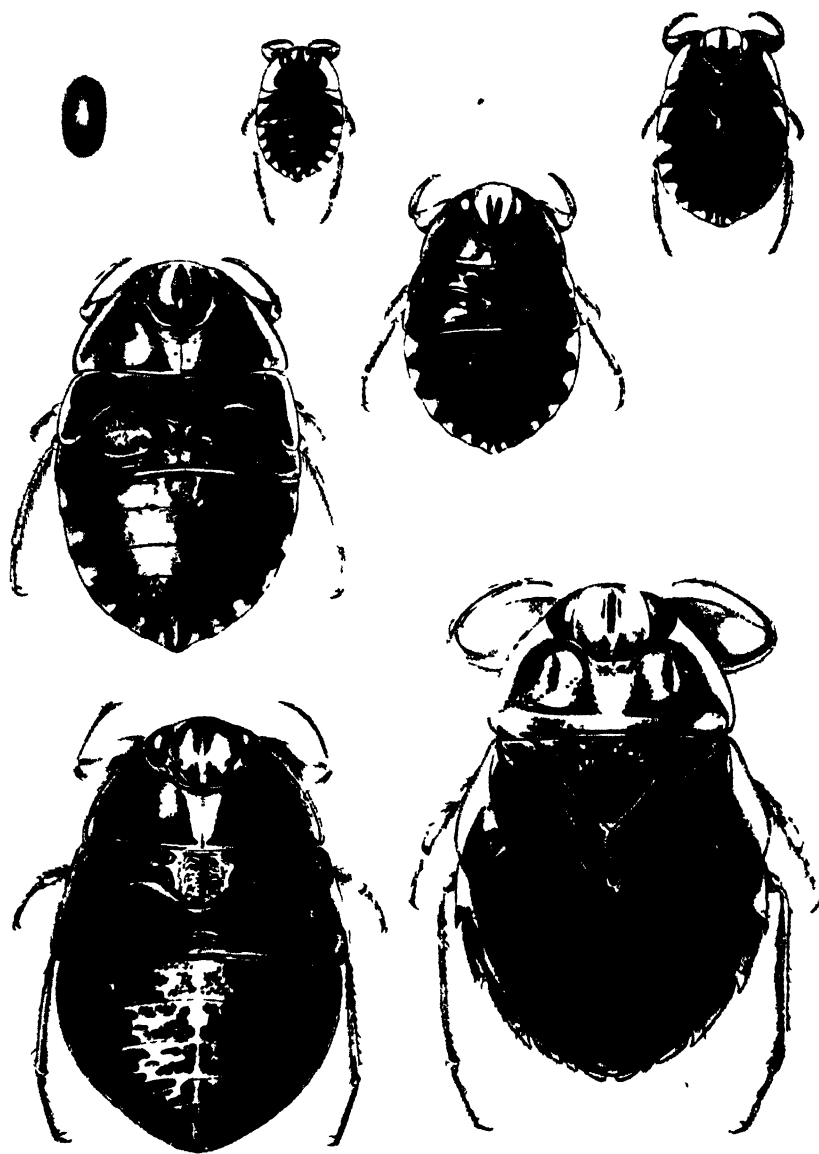
Size: Male, length, 8.42 mm.; width (embolium), 5.25 mm. Female, length, 10.42 mm.; width (embolium), 6.09 mm.

Holotype, male and allotype, female (California Academy of Sciences) Mulege, Baja California, May 14, 1921, E. P. Van Duzee. A series of paratypes, same data as type.

There is a single specimen in the U. S. National Museum, P. R. Uhler collection, labeled "San Ramundo, Lower Calif., Mex., Chas. D. Haines, April 1889."

This species will run to *hybrida* Montd. but has a much longer head and pronotum than in that species and differs from all of the species known to me in the tremendously prolonged sixth visible sternite in the female.

PLATE X



Ambrysus mormon Montd. Egg, five nymphal stages and adult

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The Relative Weights of the Major Divisions of the Brain and the Cord in Several Species of Animals

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ABSTRACT: The weights of the prosencephalon, the mesencephalon, the cerebellum and the medulla, expressed as percentages of the entire brain weight have been assembled, for the frog, chicken (both newly hatched and adult), albino rat, turtle, cat (fetal, newborn and adult), dog and man.

The relative weights of the prosencephalon increase with the increase in complexity of the animal, the relative weights of the mesencephalon decrease and the relative weights of the medulla decrease in the higher forms but this change is not quite so regular as in the first two parts of the brain. The percentage weights of the cerebellum are the most irregular.

The weights of the spinal cords, expressed as percentages of the total brain weight show a general decrease from the lower animals up to man. This does not apply to the adult chicken, and the turtle cord. The turtle cord is 120 percent of the weight of the turtle brain.

The relative weights of the prosencephalon and the percentage weights of the cord illustrate very well the cephalization of the nervous system in this small group of animals.

DURING the latter part of the last century and the early years of the present century, there has been a marked change in the methods of studying the brain and also in the emphasis on the basic units of morphological structure. Before this time, the brain was thought of as a series of segmental parts, each with its functions, and more or less united with the parts anterior and posterior to it. The "American School of Neurology", as it has been called by Herrick (1943), has revolutionized the approach to the study of the brain, both human and comparative, by the substitution of the longitudinally arranged functional divisions, in place of the former segmental, or developmental, units. This change has been brought about to a very large degree by Herrick's first paper on "The cranial and first spinal nerves of *Menidia*" published in 1899, and by a long series of subsequent papers. This new method is, with-

out doubt, the best method for studying the structure of the brain, but it is difficult to get quantitative measurements of these tracts without long and tedious methods. The study of the segmental divisions does give some idea of the changes in proportions in the brains in different groups of animals. It may be impossible to differentiate quantitatively between the frontal lobe of a male or a female brain, or to distinguish these lobes in a white or a colored brain, as has been stated by Mall (1909), yet there are very significant and very instructive differences between the various major divisions of the brains of different species of animals.

Detailed studies of the quantitative structure of some of these brains have already been published (see references), but it seemed best to collect them together for more adequate comparisons. This summary does not mean that these studies are completed, for this is merely a beginning and many more studies of the relative proportions of the major divisions of the brains of various species of animals are needed to complete the picture. In addition to these studies of the gross divisions of the brain, we need more quantitative studies of the layers of the brain, the dimensions and relative weights of the tracts and nuclei and other finer details of brain structure studied by means of quantitative methods. Neurology for some time has been a descriptive science and more recently it has entered the experimental field and the next advance should be a more exact or statistical study of the various parts of the brain.

The weight of the entire brain in man and also in many animals has been determined many times and no attempt will be made to review this very voluminous literature. There is a much smaller number of studies on the weights of the various parts or divisions of the brain, either human or comparative, and an even smaller number of weights of the spinal cord. The meagerness of the weights of the cord may be due in part, at least, to the arduous task of removing all of the cord from a vertebrate animal.

One of the earlier studies on the weights of the parts of the brain was made by Marshall in 1892. The knowledge that we have today of the quantitative anatomy of the nervous system of the albino rat is due largely to the leadership of H. H. Donaldson. In 1909 he assembled the then known quantitative data on the growth of the brain and in subsequent years published a series of papers on the quantitative anatomy of the nervous system. In 1924 he again gathered the results of his work and that of many others in a very complete quantitative description of the various systems of the albino rat.

In the work of Dunn (1921 and 1926) we have an excellent description of the quantitative growth changes in the human brain during the fetal period. Stewart (1918) has studied the weights of the parts of the brain in the rat, both in control and in experimental animals. Mall (1909) has studied the various measurements of the frontal lobe of the human brain and has published a series of weights of the cerebellum in both white and colored males and females. Ellis (1920) has reviewed the earlier literature on the growth of the cerebellum and has reported the changes in the cerebellum with advanced age. The careful accurate work of Craigie (1924, 1925, and 1931) and Drummond (1944) on the vascular supply of various parts of the brain must not be omitted from the list of quantitative studies on the nervous system. More studies like the preceding are needed and also studies on the finer details of the brain, like that of Sugita (1917) on the thickness of the cortex of the albino rat, and Suitsu (1920) on the growth of the corpus callosum of the rat.

PARTS OF THE BRAIN

Unfortunately there have been some differences in the methods of dividing the brain for these quantitative studies, but still the relative weights of most of the major divisions can be compared, for most of the animals.

The weights of the prosencephalon, the mesencephalon, the cerebellum, and the medulla expressed as percentages of the entire

TABLE 1. Weights of the parts of the brain and of the spinal cord as percentages of the total brain weight

	Prosen- cephalon	Mesen- cephalon	Cere- bellum	Medulla	Spinal cord
Frogs (<i>Rana pipiens</i>)	50.5	24.0	† . . .	†25.5	46.39
Chickens, newly hatched	48.81	27.38	14.29	9.52	19.05
adults	55.29	21.75	13.90	9.84	89.73
Rat, albino (Donaldson)	66.48	*. . . .	14.23	*19.29	36.14
Turtles (<i>Chrysemys elegans</i>)	67.5	11.7	5.2	15.7	120.22
Cats, early fetuses	53.79	24.55	5.05	16.61	19.12
new born	83.04	5.27	5.72	6.10	8.29
adult males	74.79	4.07	14.39	6.57	22.41
Dogs, males	82.54	2.67	9.60	5.19	18.77
Man (Donaldson)	87.29	*. . . .	10.58	*1.95	1.91
(Marshall)	†87.19	†. . . .	10.76	2.06	.....
(Mall) . . . . .	.....	.....	12.40	.....	.....

†—Cerebellum and medulla weighed together.

*—Mesencephalon and medulla weighed together.

‡—Weight of mesencephalon included with prosencephalon weight.

brain weight are given in table 1. The source of the data for each type of brain is given in the first column together with the species of the animal. Those without any reference were described by the author. The data for the albino rat brains were computed from the weights in grams given by Donaldson (1924) for his older rats. The last column of this table shows the weight of the spinal cord as a percentage of the brain weight. The brains of the frogs, chickens, turtles, cats, and dogs were all dissected by the same person and the method was as uniform as possible. In the study of the brains of the cats and the dogs, more than these parts were weighed but the smaller subdivisions are not given here, for this is an attempt to show the changes in the same major divisions of the brain in the various species of animals.

The olfactory bulbs, the telencephalon and the diencephalon were all weighed together, or the sum of these divisions is given as the weight of the prosencephalon. The separation between the mesencephalon and the caudal end of the diencephalon was made by an incision starting just anterior to the anterior corpora quadrigemina on the dorsum of the brain and emerging inferiorly just posterior to the mammillary bodies and the stalk of the hypophysis. This incision was probably the most difficult to make in a constant manner. All of these dissections were made by the same person and this should help to insure a slightly more constant result. The cerebellum was removed by cutting the cerebellar peduncles on a level with the upper margins of the walls of the medulla. Thus the weight of the pons is included with that of the medulla. The constricted isthmus rhombencephali is a most excellent landmark for the separation of the mesencephalon and medulla. The medulla and cord were divided at the level of the occipital condyles. The head was cut from the body by an incision passing as close as possible to the occipital condyles thus dividing the cord from the medulla at the level of the roots of the first spinal nerve. In the frogs the cerebellum was so small that it was not separated from the medulla and the two were weighed together.

The data on the rat brains give no percentages for the mesencephalon, for the mesencephalon and the medulla were weighed together, and listed as brain stem. The data for the human brain as taken from Donaldson's data (1909) likewise includes the weight of the midbrain with that of the medulla. Marshall (1892) has included the weight of the midbrain with that of the prosencephalon.

The only part of the data given by Mall (1909) which would fit in with the percentages given here was that for the cerebellum.

The data were arranged to show the increasing percentage weights of the prosencephalon in the adult animals. The prosencephalon increases from about half of the total brain weight in the frog to a little over 87 percent of the total brain weight in man, or the prosencephalon in man is 72.67 percent greater in relative weight than that of the frog.

The mesencephalon decreases in relative weight in these adult forms. From the frog to man the mesencephalon decreases 88.88 percent. The newly hatched chick and the early fetal cat are the only forms with a relatively larger mesencephalon than that of the frog, and in both of these the relative weight of the mesencephalon decreases with age, as shown in the earlier papers (Latimer, 1925 and 1938), so that the percentages of the mesencephalon form a series decreasing with the development of the animal.

The cerebellum varies from 5.2 percent of the weight of the brain in the turtle to a maximum of 14.39 percent in the adult cats. It has been shown that there is a certain correlation between the growth of the cerebellum and the musculature in the postnatal development of the chicken (Latimer, 1925) and if we compare the relative size of the cerebellum and the relative weight of the musculature in those adult forms for which the weight of the musculature is known, we will find an interesting relationship. We have the weights of the musculature for the cat (Latimer, 1944), the rat (Jackson and Lowrey, 1912) and man (Scammon, 1933). The muscles of the cat form 50 percent of the weight of the body and the relative weight of the cerebellum is 14.39 percent of the brain weight; in the rat the muscles form 45.4 percent of the body weight and the cerebellum, 14.23 percent of the brain weight and in man the muscles form from 40 to 45 percent of the body weight and the cerebellum forms but 10.67 percent of the total brain weight. Of course there should be more forms available to make definite conclusions, but from these data it would appear that there is a relationship between relative weights of the muscles and the cerebellum. It would appear that with a relatively greater amount of muscles a relatively larger cerebellum is necessary. The disparity between the percentage weights of the cerebellum in the dog and the cat is interesting. One would think them about equal in activity and muscular development. The difference may be explained, in

part at least, by the relatively greater weight of the prosencephalon. Unfortunately there are no known data on the weights of the musculature in the dog.

In his study of some of the parts of the brain, Mall (1909) has given the weights in grams for the cerebellum in several white and black males and in 22 black females. He did not study these statistically but we have determined the averages, the coefficients of variation and the significant differences for these absolute weights and for a smaller number of percentage weights, and these are shown in table 2. The percentages were calculated from his data. The smaller number of percentages is due to the failure to give the total brain weight for all of his specimens. The difference of 0.80 between the cerebellar weights in the white and black males of course is not significant. The difference of 3.75 between the weights of the cerebellum in the black males and females is statistically significant. A study of the weights of these cerebelli as percentages of the total brain weight likewise shows no significant difference between these percentages in the males of the two groups but there is a probably significant difference of 2.15 for the percentages of

TABLE 2 Average cerebellar weights, coefficients of variation and significant differences computed from the original data of Mall, for white males (W. M.), black males (B. M.) and black females (B. F.).

NUMBER OF CASES	Average weight in grams	Coefficient of variation	Significant difference
W. M. 39	166.82 \pm 1.96	10.89 \pm 0.84	0.80 3.75
B. M. 54	164.78 \pm 1.62	10.68 \pm 0.70	
B. F. 22.	154.41 \pm 2.24	9.85 \pm 1.04	
	Average percentage weights		
W. M. 26.	12.40 \pm 0.18	10.78 \pm 1.02	0.063 2.15
B. M. 41	12.41 \pm 0.16	12.36 \pm 0.93	
B. F. 14.	13.08 \pm 0.26	10.76 \pm 0.14	

the cerebellum in the two sexes of the black race. The number of cases is not very large but these figures do show that in the black race the male cerebellum is statistically heavier in absolute weight than the female cerebellum, and also that the female cerebellum probably forms a larger part of the total brain weight.

The coefficients of variation for all of these weights, both the weights in grams and the percentage weights are remarkably similar, and they are fairly low, indicating a rather low degree of vari-

ability. There is not the difference between the coefficients for the absolute weights and the percentage weights which one usually finds. The lowest coefficient is that for the weight in grams of the cerebellum in the black females, and the highest is for the percentage weights of the black male cerebellum. This maximum coefficient is but 1.25 times the smallest coefficient. The average of the three coefficients for the absolute weights is 10.47 and that for the three coefficients for the percentages is larger or 11.30. The percentage weights of the parts of the dog brain were also more variable than the absolute weights (Latimer, 1942).

A most excellent study by Larsell and von Berthelsdorf (1941) shows that there is a very definite relationship between the surface areas of the divisions of the ansiform lobe of the cerebellum and the weights of the musculature of the fore, and the hind limbs in six species of mammals.

Table 1 shows the medulla of the rat as heavier than any of the other forms but this weight includes the weight of the mesencephalon, small though it may be. In the frog, the cerebellum and medulla were weighed together. The medulla of the turtle is possibly the greatest in relative weight and the medulla of man forms the smallest proportion of the brain weight. The postnatal growth of the chicken medulla follows the increase in total body weight very closely. The percentages for the cat show that in the fetal period, the medulla decreases from 16 to 6 percent of the brain weight. There is less change in the postnatal period than in the fetal period. We have no data for the changes in the postnatal growth of the cat nervous system, but there is little change between the percentage weight of the medulla at birth and in the adult cat.

The cephalization, or the increase in the relative size of the prosencephalon, in this small series of animals, has been shown above. The development of the suprasegmental parts of the brain, or the relative weights of the prosencephalon and the cerebellum taken together, show even better the changes in these brains. The weight of the diencephalon is included with that of the hemispheres in the weight of the prosencephalon in all of these animals. If it were listed with the brain stem it would change the results but slightly. The increase in the percentages of the suprasegmental parts of these brains is as follows: frog, 50.5; adult chicken, 69.19; turtle, 72.70; rat, 80.71; adult cat, 89.19; dog, 92.14; man, according to Donaldson's data, 97.87, and man according to the data given by Marshall, 97.95 percent. The entire brain stem, or the mesencephalon and

the medulla together, shows a corresponding decrease from 49.5 percent in the frog to 1.95 percent in man. In this series, based on suprasegmental percentage weights, the turtle falls into what is probably its proper sequence, or between the chicken and the albino rat, rather than the place it has in table 1, which is based on the relative size of the prosencephalon alone.

In the chicken, the suprasegmental parts increase from 63.10 to 69.19 between hatching and maturity. In the cat, the percentages are 58.84 in the early fetus; 88.76 in the newborn kitten, and 89.18 in the adult cat. These percentages as well as the more detailed data in table 1, show the prosencephalon and the suprasegmental parts of the brain are relatively heavier in the better developed animals.

These percentage changes in the four parts of the brain are shown graphically in figure 1. This shows very clearly the relative increase in the prosencephalon (1 in figure 1) in these various species of animals. The relatively smaller proportion of the prosencephalon in the young of the chicken and of the cat are well shown in this figure. The corresponding decrease in the relative size of the adult mesencephalon (2 in figure 1) is well shown and also the relatively larger mesencephalon in the young of the chicken and the cat. The medulla (4 in figure 1) decreases also in relative weight with increase in complexity of the animal form, but this change is not so regular. With the exception of the turtle, the cerebellum (3) is the least variable in the adult forms.

SPINAL CORD

The last column of table 1 shows the weight of the spinal cord expressed as a percentage of the weight of the brain. There is more variation in these percentages than in any of the other columns. They range from 1.9 percent of the brain weight for the human cord to 120 percent for the cord of the turtle. For the rat, the cat, the dog, and man there is a perfect inverse ratio between the relative size of the prosencephalon and the relative weight of the cord. If the percentage weights of the prosencephalon and the spinal cord are compared in these four species, we find that the prosencephalon is 1.84 times the weight of the cord in the rat; 3.34 times, in the cat; 4.40, in the dog and 45.70 times the weight of the cord in man. Thus there is shown the cephalization of the nervous system, not only in the increase in the relative weight of the prosencephalon, as described above, but in the relatively greater weight of the entire brain compared to that of the spinal cord.

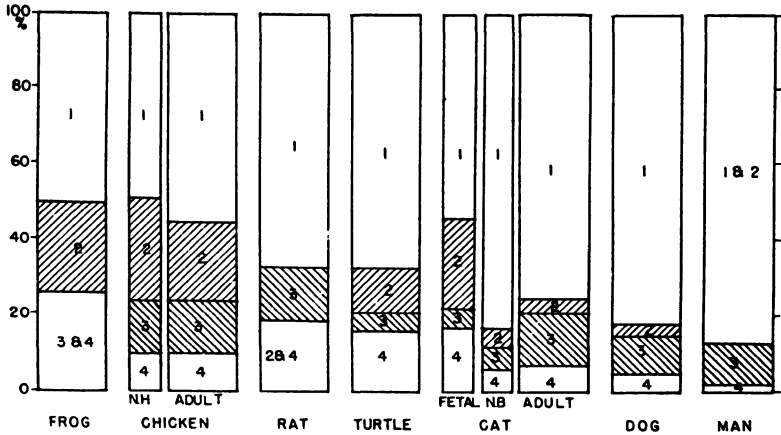


FIG. 1. The weights of the four major divisions of the brain shown as percentages of the total brain weight. 1, represents the percentage weight of the prosencephalon; 2, the mesencephalon; 3, the cerebellum and 4, the medulla. The numerical values of the percentages shown graphically here are given in table 1.

The relatively heavy cord in the turtle may possibly be explained by the powerful musculature necessary for moving the heavy shell, together with the relatively undeveloped brain. The relatively large cord in the chicken is unexpected. As a rule the chicken is thought to be more highly developed than the frog. The prosencephalon of the chicken is but slightly heavier than that of the frog (1.09 times greater) but the cord is nearly twice the relative weight of the cord

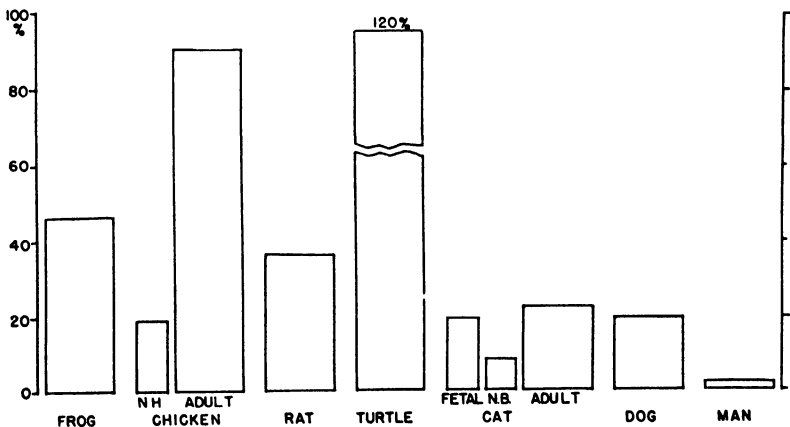


FIG. 2. The weights of the spinal cord expressed as percentages of the brain weight are shown graphically. The numerical values of these percentages are given in table 1.

of the frog (1.93 times). Does this perhaps mean that there are many more, and also more complicated, reflex activities in the chicken which are centered in the cord?

These weights of the cord, shown as percentages of the brain weight, are represented graphically in figure 2. This figure does not present the regular and consistent changes shown in the preceding figure, especially for the percentages of the forebrain. If the percentages of the cord in the adult chicken and the turtle are omitted, then there is a fairly regular decrease in the weight of the cord, compared to the total brain weight.

SUMMARY

The weights of the prosencephalon, the mesencephalon, the cerebellum and the medulla, expressed as percentages of the entire brain weight have been assembled, for the frog, chicken (both newly hatched and adult), albino rat, turtle, cat (fetal, newborn and adult), dog and man.

The relative weights of the prosencephalon increase with the increase in complexity of the animal, the relative weights of the mesencephalon decrease and the relative weights of the medulla decrease in the higher forms but this change is not quite so regular as in the first two parts of the brain. The percentage weights of the cerebellum are the most irregular.

The weights of the spinal cords, expressed as percentages of the total brain weight show a general decrease from the lower animals up to man. This does not apply to the adult chicken and the turtle cord. The turtle cord is 120 percent of the weight of the turtle brain.

The relative weights of the prosencephalon and the percentage weights of the cord illustrate very well the cephalization of the nervous system in this small group of animals.

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THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

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The Skeleton of the Lizard *Xenosaurus grandis* (Gray)

By SHIRLEY BARROWS and HOBART M. SMITH

ABSTRACT: The skeleton of the lizard *Xenosaurus grandis* (Gray) is studied in detail. As a result of the study, the validity of the family XENOSAURIDAE is confirmed. Its closest relatives are in the family ANGUIDAE. Otoliths and palpebral bones are reported for lizards.

INTRODUCTION

ALTHOUGH a few scattered notes on the osteology of *Xenosaurus* Peters have appeared (as in Cope, 1900, and Camp, 1923), in the 90 years since the genus was made known (first species described in 1856), the skeleton has received little attention and has never been fully described. In view of the strange appearance of the animal this lack of knowledge probably is to be attributed to the scarcity of specimens. Prior to 1937 very few specimens had been collected. In that year, however, Doctor Edward H. Taylor discovered a locality in Veracruz at which the species is abundant, and numerous specimens were obtained. During parts of 1938 and 1939, the junior author secured about a hundred specimens of the species during tenure of the Walter Rathbone Bacon Travelling Scholarship of the Smithsonian Institution. The present study is based upon a few specimens of that series and certain ones of the Taylor series.

Fossil remains of *Xenosaurus* are unknown, and its origin can be determined only by the indications afforded by the morphology of the living species. Until recently only one species, *Xenosaurus grandis* (Gray) was known (pl. 11, figs. 1, 2); it has been recorded from a small area near Orizaba in central western Veracruz, Mexico (Cuautlapan, Córdoba, Huanusco, Orizaba), and from "Tehuantepec," Oaxaca. In 1941 Stuart described a very closely related species, *X. rackhami*, known from Chiapas and Guatemala, which

differs, at least externally, only in minor scale characters. These two are the only species known in the genus.

No known genera are closely allied to *Xenosaurus*. Its species resemble superficially certain members of the family Xantusiidae (as for instance species of *Lepidophyma*), but there is no close relationship between them. As concluded by Gilmore (1928) the true relationship is with the superfamily Anguioidea, to which belong the families Helodermidae, Anguidae and Anniellidae. The extent of the relationship with the Helodermidae has been a subject of some conjecture; and it has been suggested that *Xenosaurus* is more closely related to that family than to any others now known. Whatever may be the extent of this relationship, it has generally been the custom to assign *Xenosaurus* to a family of its own.

The object of this study has been the description of the skeleton of this hitherto poorly known species; to reestimate its taxonomic (especially family) ranking; and to evaluate its relationship to other groups of the superfamily Anguioidea.

MATERIALS

Five specimens of *Xenosaurus grandis*, from the E. H. Taylor-H. M. Smith collection, obtained at Cuautlapan, Veracruz, furnished the basis for the present study. One entire specimen had already been skeletonized by the use of dermestids; another was stained with toluidine blue (specific for cartilage), and alizarin red (specific for calcium of bone and cartilage). Two skulls were cleaned and disarticulated by boiling in dilute (.1%) sodium hydroxide for ten minutes. One skull, after preliminary removal of the bulk of the muscles, was stained for cartilage only with toluidine blue. The remaining portions of the specimens were reserved for dissections.

One mounted skeleton of *Heloderma suspectum* from Arizona, in the University of Rochester collection, and several skeletons of various species of gerrhonotine lizards, including *Gerrhonotus imbricatus* Wiegmann, *G. coeruleus* Wiegmann, *G. gramineus* Wiegmann, and *G. liocephalus* Wiegmann, have been available for direct comparisons with *Xenosaurus*.

For information supplementary to that revealed by these specimens we have found most useful the articles by Camp (1923), Gilmore (1928) and Shufeldt (1890).

Since we have made no attempt at a complete study of the soft parts of *Xenosaurus*, we have depended on the works of DeBeer (1937), DuBois (1943), Gilmore (1928), Watkinson (1906), and

Young (1942) for naming such features as the nerve and blood vessel foramina, and certain other parts associated with the skeleton.

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We are indebted to Doctor Edward H. Taylor for the loan of a skeleton and other specimens of *Xenosaurus*, and for suggestions during the course of the study. The skeletons of *Gerrhonotus* were made available by Doctor Joseph Tihen, to whom we are indebted also for a number of suggestions. For financial assistance in the preparation of drawings we are indebted to the University of Rochester, through the kindness of Doctor Curt Stern and Doctor Sherman C. Bishop. Most of the drawings were made by Jean Adolph; a few are the work of Natt C. Jacobs, medical illustrator of the University of Rochester Medical School. Others to whom we are indebted are Miss Barbara Leonard, Mrs. Jean Palmer, Doctor Arnold Grobman, and Doctor Claude Hibbard. Miss Barbara Leonard and Mrs. Jean Palmer have our gratitude for their generous and careful supervision of most of the staining operations.

CRANIUM

For convenience of treatment the cranium is considered apart from the lower jaw. The former is treated in two sections, the (1) bony cranium and (2) cartilaginous cranium.

BONY CRANIUM

Five unpaired bones (premaxilla, frontal, parietal, otoccipital and sphenoid) are present in the cranium; the otoccipital and sphenoid are fused in old adults, separate in juveniles and young adults. (Pls. XII, XIII.) Eighteen paired bones occur (nasals, maxillae, septomaxillae, prefrontals, lacrimals, palpebrals, jugals, postorbitofrontals, squamosals, tabulares, quadrates, prevomers, palatines, pterygoids, ectopterygoids, epipterygoids, columellae and otoliths), in addition to 2 pterygoid sesamoids, and about 20 sclerotic bones in each orbit making up each sclerotic ring. The total number of bones is 41 excluding the sclerotics and sesamoids, about 83 with them.

Premaxilla: The premaxilla is a single median bone articulating with the prevomer, septomaxilla, maxilla, nasal, and frontal. In anterodorsal view it is an elongate triangular bone having its base at the tip of the skull, and its sides sharply indented at two points equidistant from each other and from the end of the bone; in lateral view the anterior tip is blunt while the posterior two-thirds

forms an obtuse curve. The exterior is covered by coössified osteoderms except a thin smooth border above the teeth. A sharp posterior tip overlaps a similar tip on the frontal. The maxilla articulates with the premaxilla along its lateral border as far back as the posterior indentation. From this point to the posterior extremity the bone is bordered by the nasals.

On the ventral side, at the point of the first indentation a shelf (palatal process) protrudes posteriorly, forming the extreme anterior floor of the skull. In the center on the ventral side of the shelf is a blunt, knobbed, sometimes bilobed, incisive process projecting ventrally. A sharp median ridge extends from the posterior point of the bone forward to the palatal process. Nine pleurodont teeth are present; the bases of the teeth are pierced by small foramina. Seven labial foramina are visible externally at about the level of the bases of the teeth; these foramina terminate the superior premaxillary canals which radiate from a pair of larger foramina on the internal face of the bone dorsal to the palatal processes; four labial foramina are connected with the right internal foramen, and three with the left. Immediately below the posterior foramina of the superior premaxillary canal are the openings of the small inferior maxillary canals, which terminate ventrally on either side of the incisive process.

In the articulated skull the premaxilla is narrowly separated from the frontal (by contact of the nasals) in dorsal aspect, while in ventral aspect it is narrowly in contact with the frontal.

Nasals: The nasals are paired, dorsal roofing bones articulating with the premaxilla, maxilla, frontal, septomaxilla, prefrontal and with each other. They form a small portion of the border of the external nares posteromedially. The dorsal surface is covered with osteoderms except for a median anterior projection extending under the premaxilla and not visible in dorsal view of the articulated skull.

Viewed separately in dorsal or ventral aspect the nasal appears roughly rectangular with a pointed projection at its posterior end overlapping the frontal, and another at the anterior end underlying the premaxilla. In the skull the medial side of the bone is placed at a 30° angle with the adjacent edge of the opposite nasal. The bones articulate with each other along their median borders at a point $\frac{2}{3}$ the distance from their anterior ends; anteriorly they are separated from each other by a posterior projection of the premaxilla and posteriorly by a smaller anterior projection of the

frontal. The nasal articulates with the maxilla and the extension of the prefrontal underlying the maxilla along the anterior two-thirds of its lateral border, and with the frontal posteriorly.

In ventral view, the pointed projection under the premaxilla is seen to extend ventrad from the general level of the remainder of the bone, and barely to reach the level of the dorsal surface of the anterior end of the septomaxilla; the median edge of this process is straight and involves $\frac{1}{2}$ of the median length of the bone. Posterior to this straight edge, the rough protuberance for articulation with the other nasal is seen. The actual articulation is not visible ventrally in the articulated skull, as it is covered by a junction of the frontal and the premaxilla. Posterior to this protuberance the bone is concealed by the frontal, in ventral view.

The exposed ventral surface of the nasal forms the dorsal roof of the nasal capsule. It is accordingly smooth and has a median longitudinal shallow concavity, the median and lateral edges of which are slightly elevated.

Frontal: An unpaired median element articulating with the postorbitofrontal, parietal, nasal, premaxilla and prefrontal.

It is a roughly triangular bone with a narrow, elongate forward apex separating the orbits from each other. Its dorsal surface, where exposed, is covered by coössified osteoderms. The posterior base of the triangle, nearly straight, forms a suture along its entire length with the parietal. The lateral wings slightly overlap the postorbitofrontal and fit into a notch in the latter bone. About $\frac{2}{3}$ of its total lateral margin borders the orbit in front of the postorbitofrontal. A suture with the prefrontal occupies most of the lateral border anterior to the middle of the frontal (measured along the median line). The pointed posterior ends of the nasals overlie the entire anterior margin of the frontal save for a very narrow median tip which underlies the premaxilla. The frontal is slightly overlapped by all bones which contact it anteriorly.

On the ventral surface (pl. 14, fig. 4) a rounded ridge borders the posterolateral margins. Anterior to a point just back of the portion bordering the prefrontal, the ridges become sharper and more elevated and enclose a conspicuous, narrow, longitudinal median groove expanding somewhat anteriorly. The ridges become narrow (laterally compressed) anteriorly and are continuous with the prefrontal to form the anterior (internal) border of the orbit.

Parietal: A single bone articulating with the frontal, postorbitofrontal, tabulare, squamosal, and otoccipital. It is extensive, quad-

angular with concave sides, and forms the median posterodorsal roof of the cranium. Most of its dorsal surface is roughened by numerous coössified osteoderms, but these markedly decrease in prominence toward the lateral edges of the bone and disappear entirely in two semicircular regions on the posterior border. Near the anterior end of the bone at the midline is the parietal ("pineal" *auct.*) foramen. The lateral concave edges bound the supratemporal fossa along its entire median border. The anterolateral projection very slightly overlies the postorbitofrontal, sharing subequally with the posterolateral corner of the frontal a notch in the medial edge of the postorbitofrontal. The posterolateral projection curves slightly ventrad as it articulates with the minute tabulare along its posterolateral border, with the squamosal immediately posterior to the supratemporal fossa, and with the occipital at its extreme posterior tip. The posterior edge is concave and free, while the anterior edge forms a nearly straight suture with the frontal.

The ventral surface of the parietal (Pl. XIV, fig. 5) possesses four obtuse ridges. Two of them, the anterior ridges, converge posteriorly from the anterolateral projections, merge on the median line about $\frac{1}{2}$ the distance from the anterior margin, and continue as a median ridge to the posterior border. The posterior ridges are lower, converge anteriorly from the posterolateral projections and meet the anterior ridges a short distance in front of the latter's union, or in other words at a point equidistant from the anterior and posterior borders. The epipterygoids and anterolateral dorsal processes of the otoccipital nearly contact the parietal at the point of union of the anterior and posterior ridges. A middorsal anterior projection of the otoccipital likewise nearly contacts the parietal at the point of union of the anterior ridges.

Maxilla: This is a paired bone articulating with the jugal, premaxilla, prefrontal, nasal, lacrimal, ectopterygoid, palatine, prevomer, and septomaxilla. The maxilla forms the major part of the upper jaw and is its chief dentigerous bone. It is elongate, tapers slightly at its posterior end and has a large triangular dorsal (nasal) process arising from the anterior half. Its external face is covered with coössified osteoderms everywhere above the level of the labial foramina. Its posterior extension is separated from the lateral border of the orbit by the anterior overlying process of the jugal, and by the lacrimal. Ventrally, however, the medial palatal process projects under the jugal and forms the ventral anterolateral portion of the orbital wall. The palatal process at its posterior limit

touches the ectopterygoid. Farther forward, at the midpoint of the base line of the bone, the process widens and joins the lateral wing of the palatine. At this point, on the dorsal surface of the process, appears the inferior alveolar canal opening opposite the infraorbital foramen in the palatine; the canal divides inside the maxilla and opens externally by numerous (11) labial* foramina situated about even with the bases of the teeth. The anterior opening of the canal appears just posterior to the septomaxilla. Anteriorly the process forms a socket into which the premaxillary fits, the palatal process of the maxilla overlapping that of the premaxilla. On the median side of the anterior end of this process, the maxilla articulates with the anterior end of the prevomer. Immediately posteriorly it articulates with the septomaxilla. At its anterior external dorsal end, anterior to the nasal process, the maxilla shares the borders of the external naris with the premaxilla and the nasal. A socket-like indentation of the maxilla in the lower part of the nasal pit receives the septomaxilla. The nasal process extends between the external naris and a posterior suture with the lacrimal. The crest of this dorsal process is parallel with the base line and articulates with the lateral edge of the nasal. The bone bears 17 pleurodont teeth each of which opens basally by a very small foramen.

Septomaxilla: The septomaxilla (Pl. XIV, fig. 1) is a paired bone articulating with the prevomer, nasal, maxilla, and premaxilla. It forms the anteroventral limit of the nasal capsule. From the dorsal side it appears as a concave bone fitted on top of the suture between the maxilla and prevomer. On its median anterior border it is raised as a ridge which articulates anteriorly with the ventral side of the premaxillary and the tip of the nasal under the premaxilla, and posteriorly with the septomaxilla of the other side of the skull. Beneath this ridge is a canal which pierces the bone completely, and which in some parts is closed ventrally by the prevomer. This canal is continuous with that which penetrates the premaxilla and opens externally by the labial foramina. Posterior to the ridge, the bone has two small posterior projections lying along the median line which also articulate with the septomaxilla of the opposite side. The posterior border of the dorsal side is concave. Where it joins the medial surface of the maxilla

* DuBois (1948, p. 416) terms these foramina, "which allow small twigs of the superior alveolar branch of the fifth nerve to pass out of the bone laterally and to supply innervation to the glandular tissues in the membranes of the upper lip," the "maxillary foramina." Since however like structures occur on the premaxilla and dentary, and all serve the labial glands, they are better known as "labial" foramina.

laterally, the septomaxilla projects above the maxilla so that it is seen from the exterior above the depression of the latter bone at the nasal pit. At $\frac{1}{3}$ of the distance from its posterior end as viewed from the exterior, this part of the septomaxilla above the maxilla has a little knob projecting outward and extends forward until it meets the median ridge near its anterior end. The two ridges join in a point and continue anteriorly as a vertical ridge extending ventrad to the point at which the palatal process of the maxilla overlaps that of the premaxilla.

On the ventral side, the vertical ridge seen from the dorsal side splits into two ridges forming a v-shaped configuration with the vertical ridge at its apex. The median of these two ridges borders the median edge of the bone. Next to this ridge the bone is roughened into lobules and grooves. The lateral ridge extends in a straight line at an angle of 75° from the median ridge. It borders the lateral edge of the bone for $\frac{1}{2}$ its length anteriorly while lateral to its posterior $\frac{1}{2}$ the bone flares out to form the part which can be seen from the exterior at the nasal pit. Between the two ridges the bone is slightly depressed. Along the vertical edge of the median ridge the septomaxilla articulates with the prevomer in the anterior depression on the dorsal side of that bone.

Prefrontals: 'Paired elements articulating with the palatine, frontal, lacrimal, jugal, maxilla, palpebral and nasal. It is a roughly triangular bone forming most of the anterior limit of the inside of the orbit. The anterior apex and median border of the triangle overlap the frontal, form the anterior half of the median dorsal border of the orbit, and bear coössified osteoderms. From its most anterior dorsal border a broad triangular process projects forward from the orbit, overlapping the pointed posterior end of the nasal and bordering a dorsal extension of the maxilla. The tip of the posterodorsal process forms the second apex of the triangle. From this point the bone has a ventral concave base which extends to the third, latero-ventral apex. At the midpoint of this base is a small projection directed posteromedially. Along $\frac{1}{2}$ of the lateral part of this base, the bone articulates broadly with the dorsal extension of the palatine. The tip of the third apex barely touches the anterior tip of the jugal. The side between the third and first apices forms a broad articulation with the lacrimal; the midline of this base is indented to form a part of the wall of the lacrimal foramen. On the medial aspect of the bone beneath the first apex is a large concavity extending from the first apex to the ventral border. This indentation

is bounded posteriorly by a slight ridge extending from the first apex to the projection at the midpoint of the ventral border.

From the smooth dorsal anterior edge of the prefrontal, the triangular palpebral projects backward over the orbit.

Lacrimal: Small paired bones articulating with the prefrontal, maxilla and jugal (Pl. XIV, fig. 1). Each is rectangular and forms the lateral part of the anterior limit of the interior of the orbit. Its external surface is rough and bears a ridge, bordering the orbit, continuous with a like ridge on the jugal. Its medial surface is smooth. At its anteroventral border it articulates broadly with the maxilla. Its posterior end narrows somewhat where it overlaps the anterior projection of the jugal. Its median border, in the orbit, is irregular; the prefrontal meets it at a broad suture, in the middle of which near the dorsal limit of the median border of the lacrimal bone is the lacrimal foramen. The anterior end is overlapped by the dorsal process of the maxilla.

Palpebral: This is a paired, triangular bone articulating with the prefrontal and extending over the anterior end of the orbit. The short median base of the triangle articulates with the prefrontal along its whole length. The lateral base is free and is the longest of the three sides. The posterior base is also free and is slightly concave. The dorsal surface is smooth except for a slight depression along its lateral base. The ventral surface is concave.

Sclerotics: A series of about 20 thin, overlapping bony plates forming a ring-like structure in each orbit, attached to the skull by membranes.

The sclerotic ring is in a nearly vertical position and is convex laterally; the circular hole in its center is about half the total diameter of the ring.

Jugal: Paired elements forming sutures with the maxilla, ectopterygoid, squamosal, postorbitofrontal, lacrimal, prefrontal and palatine bones. It is a roughly chevron-shaped bone with the anterior limb much more slender than the posterior, and with an asymmetrical, obtuse ventral process at the apex. Osteoderms are coössified with it on its external surface.

The external orbital border is marked by a protruding ridge. The bone articulates with the maxilla beneath the middle of the orbit, where the slender, pointed anterior projection from the jugal extends onto the medial side of the maxilla inside the orbit. The extreme anterior tip of the same projection narrowly contacts the lacrimal, the prefrontal and the palatine bones. The ectopterygoid

protrudes narrowly to the external surface where it interrupts the extreme posteroventral portion of the maxilla-jugal suture at the labial border. Posterior to the ectopterygoid a short, blunt, labial process of the jugal extends posteroventrally to form the posterior portion of the labial border, in line with that of the maxilla. When the jaws are closed, this labial process lies immediately external to the coronoid process of the lower mandible. The posterodorsal portion of the jugal expands somewhat dorsally, where it meets the postorbitofrontal and, narrowly, the squamosal. Its posterior edge is slightly serrate.

Two foramina pierce the inner face of the jugal at its angle, near or in the labial process.

Postorbitofrontal: This name is suggested for the fused postorbital and postfrontal, a composite bone of occasional occurrence among Lacertilia. It is paired, has sutures with the parietal, frontal, jugal and squamosal, and forms the anterolateral border of the supratemporal fossa and the posterior border of the orbit. Its dorsal surface is somewhat rugose but no clearly defined osteoderms are fused with it. The jugal contacts the anterior half of the nearly straight lateral margin, the squamosal the posterior half. The anterior tip of the lateral margin is expanded into small dorsal and ventral knobs. The posterior edge, bordering the supratemporal fossa, forms an acute angle with the lateral edge, and is slightly concave. The anterior border, facing the orbit, forms an obtuse angle with the lateral edge, and projects medially, around the border of the orbit, farther than any other part of the bone. A rather deep, right-angled notch, the posterior arm shorter than anterior arm, is present on the medial edge; the notch receives a portion of the frontal and parietal, whose common suture bisects the angle of the notch.

Squamosal: Paired elements articulating on each side with the parietal, jugal, postorbitofrontal, tabulare and quadrate. Each is a smooth, arched bone forming the posterolateral border of the supratemporal fossa and of the skull. The superior surface, unlike that of other dorsal roofing bones, bears no coössified osteoderms. Its posterior extremity is a narrow process arching ventrally to make a narrow contact with the quadrate and articulating laterally with the tabulare (posteriorly) and the parietal. The bone is broadest near its middle, at the posterior border of the supratemporal fossa, where it joins the parietal. It gradually tapers anteriorly from this point, forming along its anteromedial border a long suture

with the fused postorbital and postfrontal, and terminating anteriorly at a narrow suture formed with the jugal. The bone is somewhat thickened at its outer border, but becomes rather thin toward its parietal edge.

Tabulare: A paired bone, articulating with the otoccipital, squamosal, parietal and quadrate. It is a very small, smooth, arched, sliverlike element very narrowly in contact by its posterior end with the quadrate between the squamosal and otoccipital. Over half its dorsal surface (Pl. XIV, fig. 2) underlies the posterolateral edge of the parietal. Its dorsal exposed surface is very narrow and elongate, wedged chiefly between the squamosal along its external border, and the otoccipital and parietal which share equally its medial border.

Quadrate: Paired bone articulating with the tabulare, squamosal, pterygoid, otoccipital. It is a pinna-shaped bone at the posterolateral limit of the skull. On its anterior side it is smooth and flat except for slight concavities near the center. Its outer border describes a convex curve while its inner border is concave. The bone is broader at its dorsal than at its ventral end. Its ventral edge is flattened and slightly grooved where it articulates with the lower jaw. Its dorsal surface is broad, flat and L-shaped, the base of the L being median and directed posteriorly. The roof of the skull covers the base of this L, but does not touch it. Posteriorly the L dips ventrad and broadens laterally. At its posterior extremity it forms a triangular knob with which it articulates with the rest of the skull. The squamosal joins one side of the knob, adjacent to the tabulare, which lies mesad. On the median side of the triangular area, part of the otoccipital joins the quadrate. A thickened ridge curves ventrolaterally along the posterior face of the quadrate, originating at the dorsal articular surface and disappearing near the mandibular fossa. The depression on the anterior face of the wing is shallow. The anterior edge of the bone, in lateral profile, is placed at a 75° angle.

Prevomer: The prevomer is a paired bone articulating with the maxilla, premaxilla, septomaxilla and palatine. It is an elongate bone forming the ventral limit of the nasal capsule. Accordingly it is concave on its dorsolateral side. Viewed from this direction it appears oblong in shape, with a deeply grooved projection at its posterior end where it articulates with the palatine; anteriorly the curve of the lateral edge of the oblong indents and continues forward in a straight line from the indentation to the anterior tip

of the bone. At the indentation begins a transverse ridge extending from the lateral edge to the midline of the dorsal surface. At this point it turns sharply caudad and continues as a lesser ridge of the same length at right angles to the transverse ridge. At the lateral edge of the tip of this posterior ridge is a foramen. Anterior to the transverse ridge a concavity in the bone marks the point at which the convex surface of the septomaxilla articulates. Obliquely situated, with its most anterior limit median, is a rough ridge which provides articulation with the anterior limit of the palatal process of the maxilla.

In ventral aspect the prevomer is seen to articulate at its anterior median border with the prevomer of the other side of the skull. The two prevomers are easily separable except at their anterior ends. The suture between them appears as a crevice lined by the dorsally curving median borders of the two bones. Posteriorly they diverge slightly laterally. From the median suture to the articulation with the palatine the bone presents a posteriorly enlarging rounded ridge which elevates itself ventrally to articulate with the palatine. Lateral to this ridge the bone is broad and flat. The lateral border curves gently from beneath the ridge in an arc which terminates anteriorly where the septomaxilla can be seen articulating underneath the prevomer along the anterior $\frac{1}{4}$ of the length of the latter.

At $\frac{1}{3}$ of the distance from the place where the prevomer diverges from its mate to its anterior limit a ridge arises in the midline of the bone. It is a sharp ridge, concave laterally and convex medially, rising suddenly from the flat surface of the bone, curving slightly mediad, and terminating anteriorly where the prevomer touches the maxilla at the suture of its palatal process with the premaxilla. Median to this ridge, the bone is depressed, the depression being increased by a foramen under the posterior $\frac{1}{3}$ of the ridge. Lateral to the anterior half of the ridge, the bone is elevated to the height of the palatal process of the maxilla with which it articulates. Anterior to this articulation the prevomer is depressed in a region continuous with the depression median to the anterior ridge. This depression articulates with the part of the palatal process of the maxilla which projects underneath the palatal process of the premaxilla. A small median anterior projection of this area articulates with the palatal process of the premaxilla near its midpoint.

Palatine: The palatine is a paired ventral bone articulating with the maxilla, prevomer, prefrontal, pterygoid, and jugal. Viewed

from the ventral side it appears as a Y-shaped bone, while from the dorsal surface it appears as a broad, smooth bone tapering somewhat toward its posterior end. The lateral arm of the Y has a broad suture with the palatine process of the maxilla. At the posterior limit of the suture a small flat process projects under the shelf of the maxilla and through the two bones at this point passes the superior alveolar nerve; its opening through the palatine bone is the infraorbital foramen, while in the maxilla it enters the superior alveolar canal. The median arm of the Y is slender and laterally compressed; it tapers to a fine point under the prevomer. The two arms are joined dorsally by a concave lamina of bone which articulates with the prefrontal. The body of the bone is a dorsoventrally flattened column that extends posteriorly and slightly laterad to form a V-shaped suture with the pterygoid.

Pterygoid Sesamoids: A very small sesamoid bone is present in the tendon at its point of attachment to the ventrally directed process at the union of the pterygoid and ectopterygoid.

These are not homologous with Taylor's (1940) "palatal" sesamoids, which are located at the suture between the pterygoid bones and the pterygoid processes of the basisphenoid.

Pterygoid: This is a paired bone articulating with the palatine, ectopterygoid, epipterygoid, quadrate, and sphenoid. It is a long Y-shaped ventral bone linking the other bones on the ventral side to form a complete structure. The two pterygoids are widely separated from each other medially as are the palatines, which they join anteriorly. They diverge posteriorly only slightly through the anterior $\frac{2}{3}$ of their length, but at the junction with the sphenoid they form a rather abrupt angle and diverge strongly toward the quadrate. The articulation with the palatine is formed by a median projection of the pterygoid and a lateral projection of the palatine so that the suture is oblique. Posteriorly from this articulation, the pterygoid broadens out into a flat triangular lamina in the crotch of the two arms of the Y, its base median and its apex joining the ectopterygoid. The posterior side of this lamina is elevated into a ridge, which at the juncture with the ectopterygoid forms a small knob. Lateral and dorsal to this knob, behind the ectopterygoid, is a triangular, pointed process on the pterygoid. The ectopterygoid lies on top of this smaller triangle, and sends a slender process posteriorly to lie on the dorsal face of the crotch formed of the two anterior arms of the pterygoid.

Posterior to this crotch, the pterygoid diverges laterally in a

slender process. The ventral, lateral, and dorsal sides of this posterolateral extension are flattened or concave, so that the process would appear triangular in cross-section. A ventrolateral wing from the occipital region, the sphenoid, articulates with the pterygoid at the anterior end of the posterior process. The epipterygoid fits in a socket on the dorsal side of the pterygoid immediately adjacent (laterally) to the articular surface of the sphenoid. Tapering slightly posteriorly, the posterior process is applied to the median surface of the quadrate just above the articular surface for the lower jaw.

Ectopterygoid: This is a paired lateroventral bone articulating with the jugal, maxilla, and pterygoid. At its most exterior point it receives the end of the palatal process of the maxilla in a small socket. A small portion of the lip on the median side of this socket is continuous with the palatal process of the maxilla. The lateral part of the socket extends as a knob to the exterior between the jugal and the maxilla at the ventral extremity of this suture. From this socket the bone extends posteromedially, sending one slender process to overlies the dorsal surface of the crotch in the pterygoid, and another process, more blunt and stout, to underlie the ventral surface of the lateral arm of the pterygoid.

Epipterygoid: This paired bone articulates with the pterygoid and otoccipital. It is a simple straight bone appearing as a strut between the pterygoid and the roof of the skull, the latter of which, however, it does not quite reach. It extends from a socket on the dorsal side of the pterygoid, external to its suture with the otoccipital, to the dorsal edge of the lateral surface of the anterodorsal portion of the otoccipital. Where the epipterygoid joins the pterygoid it is expanded slightly to a knob. Where it joins the otoccipital it curves very slightly laterad.

Otoccipital: The otoccipital is a single compound bone forming the ventral median posterior region of the skull and articulating with the squamosal, tabulare, quadrate, parietal, epipterygoid, and sphenoid.

Viewed from the posterior aspect, the large foramen magnum occupies the center of the bone. Its ventral limit is formed by the kidney-shaped occipital condyle. The center of the condyle is the basioccipital and the lateral protuberances are the exoccipitals. Ventrolateral to the condyle and slightly anterior, the basioccipital sends ventrolaterally 2 small processes, the basioccipital tubera. The exoccipital sends posterolaterally the broad paroccipital proc-

es. which articulate with the squamosal, tabulare, and quadrate on the anterior and ventral sides of their expanded ends. The dorsal part of the foramen magnum is formed by the supraoccipital.

From the dorsal aspect (Pl. XIV, fig. 6), the supraoccipital is seen to present a low crest on the median line. The anterior end of this crest almost but not quite articulates with a small ridge on the posterior part of the midline of the parietal. Lateral to this spine are the two slight bulges of the auditory capsules fused with the occipital. Anterior to these bulges the otoccipital projects dorso-anteriorly in a vertical lamina which nearly reaches the 2 lateral anterior ridges on the ventral side of the parietal. On the sides of the anterior ends of these sheets the otoccipital articulates with the epipterygoids.

An anterior view (Pl. XIV, fig. 3) shows the large auditory capsules bulging into the dorsal portion of the cranial cavity. On the dorsal anterior edge of the otoccipital, three small concavities facing forward mark the points of attachment of parts of the cartilaginous chondrocranium; one point is on the median line, the others halfway between the median line and the anterodorsal extremity of the bone.

Sutures can be distinguished on the otoccipital which divide it into several regions. However, these sutures are not complete enough to justify considering the individual components as distinct elements.

The supraoccipital is distinguished by no sutures whatever, but is known by its general position, forming the dorsal border of the foramen magnum and the median dorsal roof of the otoccipital.

The opisthotic and the exoccipital are indistinguishably fused. The exoccipital forms the lateral borders of the foramen magnum and the paroccipital processes, while the opisthotic forms the region ventroanterior to these processes. The junction of this fused element with the supraoccipital on the lateroanterior part of the roof of the otoccipital cannot be seen, nor is its dorsal suture with the pro-otic evident, supposedly somewhere along the paroccipital process. The lateral articulation with the pro-otic can be seen, however. It is a short curved suture extending ventroanteriorly from the ventro-anterior border of the fenestra ovale to a point anterior to the fenestra ovale and apertura lateralis and on a line midway between these two. The more dorsal articulation of the opisthotic with the basioccipital is seen in this region also. It extends in a curve from the ventral limit of the suture between the pro-otic and this element to the posterior dorsal border of the apertura lateralis. The posterior articulation between the opisthotic and the basioccipital is probably

from the posterior border of the apertura lateralis to near the edge of the foramen magnum above the occipital condyle.

The basioccipital is the region of the otoccipital forming the ventral border of the foramen magnum, constituting the ventral floor of the compound bone and bearing the basioccipital tubera. Its posterior lateral border in the region of the fenestra ovale, of which it forms the ventral border, is bounded by the opisthotic. Anterior to the suture with the opisthotic in front of the fenestra ovale the line of the bone drops ventrad. For a short distance it articulates with the pro-otic. Anterior to this, it has a clear articulation with the posteriorly directed processes and the straight posterior border of the sphenoid.

The pro-otic is a large element forming the lateral part, the latero-ventral part, and the laterodorsal part of the otoccipital. Its ventral border touches largely the sphenoid and has a small articulation with the basioccipital. The ventral posterior border underneath the apertura lateralis articulates with the opisthotic. However, the dorsolateral and posterodorsal fusions with the exoccipital and supraoccipital are quite indistinguishable. Probably the pro-otic extends posterolaterally on the dorsal side of the paroccipital process for about one-half of its length.

A tiny bone at the dorsal edge of the tip of the paroccipital process, in contact with the tabulare and parietal, is almost unquestionably the same as the bone figured by Camp (1923: 481, fig. 109) in *Xestops* and labelled "paroccipital." This name was retained by Gilmore (1928: 141), who regarded Camp's specimen as representative of a genus and species (*Melanosaurus maximus* Gilmore) different from the ones to which Camp referred it. Regardless of actual identity, the name paroccipital seems scarcely admissible since it is now generally accepted as a synonym of the opisthotic, a bone which is fused with others and forms a large part of the otoccipital bone in *Xenosaurus* as well as in other lizard genera.

While the element in *Xenosaurus* and *Melanosaurus* is situated at the dorsal edge of the tip of the paroccipital process, it seems very similar to the element at the ventral edge of the same process found by Beddard (1905: 6, 7, fig. 3) in *Uromastix* and by Versluys (see Camp, 1923: 348) in some 13 other lizard genera of various families. According to Camp, Versluys "shows it to be essentially a cartilaginous epiphysis on the tip of the paroccipital process formed partly *in situ* and largely from the columellar and epihyal cartilages which extend dorsally to form paroccipital connections that persist in certain forms. . . ." We accordingly tentatively identify the ele-

ment in *Xenosaurus* and *Melanosaurus* as separately ossified epiphyses of the paroccipital processes.

The otoccipital has many foramina which aid in orienting the positions of the fused elements.

The apertura lateralis is dorsal to the basioccipital tubera and is bordered by the basioccipital and the opisthotic. It is narrowly elliptical in shape with its long axis directed ventroanteriorly. From the anterior, the apertura medialis can be seen on the interior as an elliptical foramen near the floor of the foramen magnum continuous with the apertura lateralis.

The foramen ovale is dorsal and slightly anterior to the apertura lateralis. It is a broader ellipse with its long axis directed anteriorly and posteriorly. It is bordered by the opisthotic and the pro-otic.

Through the fenestra ovale can be seen the foramen perilymphaticum, a round hole near the lateral border of the fenestra ovale, joining the auditory capsule with the apertura lateralis and medialis.

The pro-otic incisure, enclosing the ganglion of the trigeminal nerve, is on the ventral part of the anterior border of the pro-otic.

The facial foramen lies on the anterior part of the pro-otic, about $\frac{2}{3}$ of the distance from the pro-otic incisure to the fenestra ovale, and ventral to the level of the crista parotica; it is partially concealed by an overhanging ridge (for the hyomandibular nerve) continuous with the carotid fossa posteriorly, and with the ridge overhanging the palatine nerve anteriorly.

The anterior acoustic foramen can be seen by looking through the foramen magnum from the anterior end. It is a small foramen, hidden by a bulge in the bone, dorsal to the facial foramen.

Posterior to the anterior acoustic foramen is the large oblong posterior acoustic foramen, easily seen from anterior aspect.

Externally from the posterior aspect four small foramina are seen lateral to the occipital condyle. The largest, dorsal one is the jugular foramen. The three smaller ventral ones, the two lateral of which are joined by a groove, are the hypoglossal foramina; they are visible on the interior of the brain case, where they form a nearly straight horizontal row under the posterior edge of the otic capsule.

Through the anterior end of the foramen magnum can be seen the foramen endolymphaticum near the dorsal limit on the median side of the bulge of the auditory capsule.

The Vidian canal, abducens foramen and carotid foramen are described below.

Sphenoid: The fused parasphenoid and basisphenoid bone is called the sphenoid. It is a V-shaped bone in the median region of the ventral side of the skull forming the connection between the otoccipital and pterygoids. It is closely fused with the occipital and will not disarticulate from it, but the sutures between the two bones are clearly traceable in their entirety in the smallest of 3 skulls of adult specimens. Two lateral projections from the posterior edge of the sphenoid lie on the ventral surface of the otoccipital. Anterolaterally the bone bears two stout, elongate projections which articulate with the pterygoids by a broad expansion at their tips. These projections represent the indistinguishably fused parasphenoid, the rest of the bone being basisphenoid.

From the anterior view a deep depression, the sella turcica, is seen in the sphenoid dorsal to the pterygoid processes. This depression is bounded by a thin lamina dorsally and laterally, and ventrally by a thicker lamina which bears two knobs on its free anterior edge. Between these two knobs the sphenoid articulates with the cartilaginous trabecula cranii. The bone terminates posteriorly in a nearly straight transverse suture visible from either dorsal or ventral aspect.

A small abducens canal pierces the lateral surface of the sella turcica and emerges on the dorsal surface of the bone, near the lateral edge, at about the middle of the base. The larger Vidian canal for the palatine nerve opens posterolaterally at the base of the pterygoid processes, where it is shared with the internal carotid artery, and anteriorly terminates by two foramina, one immediately posterior to the knob in the ventral border of the anterior fossa (for the palatine nerve) and the other at the dorsomedial edge of the base of the pterygoid process.

Columella: The columella consists of the bony stapes and the extracolumella. The former is a small, straight, slender, paired element expanded slightly at each end, extending from the extracolumella near the tympanic membrane to the membrane stretched across the fenestra ovale.

Otoliths: Two white oval otoliths, one in each auditory capsule, can be seen through the fenestra ovale. They are present in all three skulls examined.

CARTILAGINOUS CRANIUM

A single skull stained for cartilage only, with toluidine blue, reveals most but not all the features of the cartilaginous cranium in the adult. The nature of the cartilaginous portion of the nasal

capsule is not evident. Otherwise the parts are fairly clear. The chief remnants in the adult are in the orbital and temporal regions; most evident among these are the interorbital septum, planum, suprasedale, taenia marginalis, taenia medialis, pila accessoria, pila antotica, pila metoptica, subiculum infundibuli, trabecula communis, trabecula cranii, processus anterior tecti, and a very small part of the processus ascendens (Pl. XV, fig. 1). These remain in varying degrees of degeneration; the planum suprasedale and subiculum infundibuli are poorly developed, and the pila antotica and pila metoptica are very short and incomplete. Other portions are dimly evident. The stain is not perfect, however, so that some very thin cartilaginous areas are not stained differently than the membranes that occlude the fenestrae; thus the full extent of the cartilage may not have been realized.

Aside from that present in the orbitotemporal and nasal regions, the only cartilage remnants are Meckel's cartilage and the extracolumella. These parts are described in detail in the following.

The Orbitotemporal Cartilage. At the dorsoanterior margin of the otoccipital bone are three points of attachment of the cartilaginous chondrocranium. One point is in the middle, and the other two on either side (Pl. XIV, fig. 6). From the median point of attachment a small cartilaginous bar extends dorsoanterior a short distance, terminating at a point of attachment on the ventral surface of the parietal bone immediately in front of the union of the two anterior ridges (Pl. XIV, fig. 6). This cartilage is the processus anterior of the synotic tectum.

From the lateral points of attachment arise the taenia marginalia, slender cartilaginous rods which pass anterodorsally along the dorsal border of the otoccipital; reaching the anterior tip of the bone, opposite the point of union of the anterior and posterior ridges of the parietal, they leave the otoccipital and pass forward in contact with the anterior ridges of the parietal. As they reach the frontal they converge toward each other strongly, following now the posterior ridges of the frontal. The taenia disappear in the interorbital septum shortly before they reach the point at which the posterior ridges of the frontal turn forward to course parallel to each other. A horizontal ventral membrane completely floors the cavity in the frontal formed between the parallel ridges.

The trabecula communis is a rod-like cartilage attached at two points on the sphenoid (Pl. XIV, fig. 6). It bifurcates posteriorly, enclosing a small hypophyseal fenestra which is closed by a membrane.

The two roots (*trabeculae cranii*) of the *trabecula communis* fuse a very short distance in front of the sphenoid, and from that point anteriorly but a single structure is evident.

Extending between the *taenia marginalia* and the *trabecula communis* is a membrane forming the anterior wall of the brain cavity. The membranes on the two sides unite anteriorly along a line extending diagonally posteriorly from the anterior end of the *taenia* to the *trabeculae cranii*. Anterior to this point the median, vertical, interorbital septum passes forward to the nasal cavity. Its lower edge curves dorsad as it passes anteriorly, thus approaching the frontal at the nasal capsule. The anterior ventral edge of the interorbital septum is at a point about half the distance from the frontal to the medial ventral edges of the palatines. Grossly the interorbital septum appears to occlude about the dorsal half of the space between the orbits. Except for elements described in the following, the anterior cranial wall appears to be membranous; the interorbital septum appears to be a very thin cartilaginous partition.

The thickened (and stained) *trabecula communis* does not follow the lower border of the interorbital septum (which is not stained in the specimen at hand) throughout its length, but leaves it at about the middle of its length, and passes anteriorly through the septum toward the middle of the frontal. The trabecular mass becomes more diffuse as it passes through the septum, disappearing before it reaches the frontal.

The optic foramen pierces the anterior walls of the cranial cavity near their union with the interorbital septum, and just above the *trabecula communis*. It is surrounded by a membrane which occludes the remainder of the large optic fenestra. In front of the fenestra a faintly-stained cartilaginous mass extends dorsally from the *trabecula communis* to the point of union of the anterior cranial walls. At this point of union appears a narrow median band of even more faintly stained cartilage, the *planum supraseptale*. The latter cartilage is a single median mass, but expands somewhat anterodorsally to enclose the anterior portion of the cerebral hemispheres.

The *planum supraseptale* bifurcates above the fenestra ovale to form two faint cartilaginous strands, the *taenia medialis*, which pass a short distance posteriorly along the middle of either cranial wall, and soon arrive at a small quadrangular mass of cartilage from which project three cartilaginous bars. The most distinct is the dorsally-directed *pila accessoria*, which reaches and joins the *taenia marginalis*. Directed posteriorly is a short arm which termi-

nates blindly before extending more than a fourth of the distance to the otoccipital; this is the pila antotica. The third arm is directed posteroventrally toward the posterior border of the fenestra optica; it shortly disappears, but in line with it appears another cartilage, the subiculum infundibuli, immediately posterior to the fenestra optica, where it joins the trabecula communis.

The processus ascendens, in which is ossified the epipterygoid, remains cartilaginous only at its dorsal tip, where it terminates freely on the side of the anterior tip of the otoccipital. The dorsal tip of neither the otoccipital nor the processus ascendens touches the taenia marginalis.

Extracolumella: The extracolumella at the tympanic wall consists of four branches which are best seen on the internal side of the membrane. The body of the extracolumella extends from the junction of the four parts to the stapes, and comprises about $\frac{1}{3}$ the length of the columella. Of the branches on the tympanum, the pars inferior is long and broadly oval-shaped and extends anteroventrally. The pars superior (best seen from the exterior) is the same length as the pars inferior but is narrower. It projects posteromedially and connects by a ligament with the lower edge of the paroccipital process. The short tapering pars accessorius posterior projects ventrally and the similar pars accessorius anterior projects dorsally. Very near the juncture of the extracolumella and stapes is the processus internus which runs forwards to a minute pocket on the median edge of the posterior surface of the quadrate. The processus dorsalis is apparently absent.

The middle ear is somewhat degenerate. The tympanum is present but completely concealed by thick skin which is not obviously different from that on adjacent nuchal regions, but which is less rugose. The tympanum is also partly concealed posteriorly by the depressor mandibulae muscle. The structure of the columella has been but little involved in the degenerative process, however.

Meckel's Cartilage: The cartilage is present and extends from near the posterior end of the compound bone to near the anterior end of the dentary. Its exact posterior limit was not determined, but is apparently near the articular surface of the mandible. It is visible from the exterior in the elongate Meckelian groove on the medial surface of the compound bone immediately posterior to its articular surface with the coronoid. The cartilage is situated in the extreme ventral portion of the groove, where it is protected laterally on the ventral half by a ridge of the compound (prearticular portion)

bone; no or only a slight bony ridge encloses it dorsally. The cartilage passes through the inferior alveolar foramen with the nerve of the same name. For a short distance it is bounded ventrally by the angular, and for a longer distance by the splenial. Anterior to the end of the splenial (at about the level of the 7th tooth) the cartilage is exposed on the ventral surface of the dentary, which it follows in a shallow groove to very near its anterior extremity. It maintains a nearly uniform diameter throughout most of its length, but tapers distinctly anteriorly. Its diameter is about 0.3 mm., or about half that of one of the teeth near the middle of the dentary.

LOWER JAW

Only five separate bony elements occur in each lower jaw. As is typical in lizards the prearticular and articular are fused with each other, but in addition the surangular is fused with them. The whole element is termed the compound bone; and in addition to it occur the angular, coronoid, splenial and dentary (Pl. XIII, figs. 2, 3).

Compound Bone: This bone consists of the fused articular, prearticular, and surangular. It is a large bone, articulating with the dentary, angular, coronoid, and splenial, forming the posterior $\frac{3}{4}$ of the lower jaw. The posterior extremity is comprised of the fused prearticular and articular, but no sutures can be distinguished. Anteriorly, however, the suture between the prearticular and surangular are very clear, in a disarticulated jaw, underneath the lower extremity of the posterior arm of the coronoid, and it can be traced on the portion of the ventromedial surface of the bone which is concealed by the angular. In the articulated jaw none of these sutures is evident. The bone is dorsoventrally flattened, presenting its most extensive surfaces ventrolaterally and dorsomedially. In ventrolateral aspect it is seen as a broad element tapering and curving medially toward its truncate posterior tip. Its maximum width, just in front of a process protruding from the lateral border, is somewhat more than $\frac{1}{4}$ its length (in a straight line). The aforementioned process is the only irregularity visible in this aspect; the articulation with it is short and curves dorsally. The anteromedial border is extensively invaded by the angular, whose anterior edge extends scarcely farther forward than that of the compound bone, and its posterior edge nearly to the middle of the latter element. The anterior edge of the compound bone, above the angular, forms a broad right angled projection articulating with the dentary. Anterolaterally it articulates with the coronoid, and this suture continues onto the medio-

dorsal face of the bone as a nearly straight vertical line nearly reaching the ventral border. At this point, however, a narrow, elongate process extends forward underneath the coronoid to articulate briefly with the anterior leg of that bone. This coronoid process articulates along the anterior $\frac{2}{3}$ of its length with the splenial, and with the angular posteriorly. A deep, narrow Meckelian groove is visible near the medial edge of the bone terminating with the large inferior alveolar foramen (through which passes Meckel's cartilage as well as the inferior alveolar nerve) at the anterior end, and at its posterior end with the small medial foramen of the cutaneous recurrent canal; the anterior foramen immediately follows the lower end of the coronoid bone, while the posterior one is in direct line with the lateral process mentioned previously. Halfway between this groove and the lateral border is a prominent, rounded, elongate ridge extending from the coronoid bone to the condyloid process. The latter, scarcely elevated, is situated about $\frac{1}{3}$ the total length of the bone from its posterior end and bears on its dorsal face a pair of shallow concavities preceded by a short dorsal protuberance. A ridge extends from the inner border of the condyloid process to the posterior terminus of the bone, while posterolaterally the process is bordered by a shallow fossa. The extremity of the bone, posterior to the condyloid process, is of nearly equal width throughout, but is only half as broad as the rest of the element.

The term "compound bone" is in common usage for lower jaws of the snake genera *Typhlops*, *Anomalepis*, and *Helminthophis*, for an element generally considered to consist of the fused articular, prearticular, and surangular. Since presumably the same elements are involved in *Xenosaurus* we conclude the terminology should be the same in each case. The fusion of these elements in these snakes and in lizards is not assumed as an indication of relationship.

The bone is pierced by several canals, some of which have already been mentioned. The canal of the chorda tympani pierces the bone immediately posterior to the articular fossa, near its medial edge; it opens into the dorsal surface of the inferior alveolar canal immediately anterior to the posterior opening of the same.

Another canal, opening near the exit of the chorda tympani canal, extends dorsally through the bone, finally reaching the external surface near the lower lateral edge of the coronoid bone; it is the external cutaneous canal.

At the extreme posterior edge of the fossa below the arms of the coronoid bone, and partially concealed by the anterior edge of the

posterior arm, is a foramen leading into a canal which communicates with the narrow cavity of the bone; presumably the canal conducts a blood vessel.

The lateral opening (sometimes paired) of the cutaneous recurrent canal is situated on the ventral surface of the bone very near its lateral edge, immediately in front of the articular fossa; the medial opening was described above.

The inferior alveolar canal, which is shared by Meckel's cartilage, begins as described above, but is completely enclosed by the compound bone only in a very short area below and just posterior to the posterior arm of the coronoid bone. The compound bone forms the dorsal border of the inferior alveolar canal to the anterior extremity of the former, at which point the bone is notched to form the posterior half of a large foramen, shared with the dentary, which leads into the common marrow cavity of the dentary and compound bone. The remainder of the inferior alveolar canal is bordered above by the dentary, and below by the angular posteriorly, the splenial anteriorly.

Angular: The angular articulates with the surangular, splenial, dentary. It is a small, elongate bone at the midpoint of the ventromedial edge of the lower jaw. It is diagonally placed, so that its anterior edge is on the ventromedial surface of the mandible, while its posterior edge is within the medial border of the compound bone. The anterior third of its length is a pointed process bordered medially by the splenial, laterally by the dentary. Along the remainder of its length it articulates exclusively with the compound bone. On its medial surface near the anterior end it is pierced by the mylohyoid foramen, for the nerve of the muscle of the same name.

Coronoid: The coronoid articulates with the dentary, surangular, and splenial. It forms a moderately prominent coronoid process near the midpoint of the lower jaw. In medial aspect it is V-shaped with the apex of the V dorsal. The anterior leg of the V forms a ridge continuous with the lingual process of the dentary and joins the splenial in a short suture parallel to the ventral surface of the jaw. At the most posterior part of this suture, an elongate anterior extension of the surangular narrowly contacts the coronoid. The posterior leg of the V also forms a ridge, continuous with a ventromedial ridge of the surangular. This ridge differs from the preceding in that it does not form the border of the bone but rather lies along the midline of this leg. These two ridges meet in an obtuse point to form the apex of the V.

In lateral aspect the coronoid is more or less triangular, and has a poorly defined, rounded vertical ridge extending from the apex to its base line. The anterior angle of the bone projects forward into a small notch in the dentary, which in turn projects into a narrow notch in the anterior border of the coronoid.

The ventral border forms a nearly straight line, articulating largely with the dentary and, posteriorly, also with the surangular. The posterior angle of the lateral aspect of the bone is truncate, as the edge forms a transverse suture with the surangular at the dorsal crest of the jaw, then continues ventrally and is seen on the medial aspect of the coronoid as the posterior border of the corresponding leg. In the posterior angle, on the lateral aspect, is the external (lateral) foramen of the external cutaneous canal.

Splénial: The splénial articulates with the dentary, surangular, coronoid, and angular. It is a long slender bone forming the lower half of the medial side of the lower jaw. It tapers gradually to a point at the anterior end, reaches its greatest width at $\frac{2}{3}$ its length posteriorly, and narrows again sharply at its posterior end. Along its dorsal suture it articulates with the dentary at a ventral ridge (lingual process) of that bone. Along this suture, slightly anterior to the middle of the splénial is the large, elongate, lingual foramen. Another foramen, below the preceding, pierces the splénial almost exactly in its center; it is the genioglossal foramen for the ramus muscularis et glandularis of the inferior alveolar nerve which supplies the genioglossal muscle and glands under the tongue. At its broadest point, the splénial has a short suture with the coronoid. As it tapers posteriorly, the splénial extends underneath a forward process of the surangular. At the sharp angle of the ventromedian edge of the jaw, the splénial forms a long suture, the posterior 6th involving the angular, the remainder, the dentary. The bone terminates a short distance from the end of the jaw, opposite the 7th tooth of the dentary.

Dentary: The dentary articulates with the splénial, coronoid, surangular, and angular. It is the longest bone of the lower jaw and bears 22 pleurodont teeth. Its external side is vertically rounded and smooth except for a row of 8 to 10 labial foramina parallel to the row of teeth and equidistant from the dorsal and ventral borders of the bone. Its medial side projects as a ridge (lingual process), above which are placed the teeth along the midline of the jaw. At this ridge, the dentary forms a long suture with the splénial. This ridge extends backwards about $\frac{2}{3}$ the length of the

jaw, sloping gently upwards, and is continuous posteriorly with the sharply ascending ridge of the coronoid. Here the teeth end. The dentary forms a suture with the coronoid in front of the coronoid ridge. On the dorsal border of the jaw, the dentary extends backwards into a small pointed notch in the coronoid. Under the edge of the coronoid the bone continues posteriorly, meeting the surangular at a broad, obtusely notched suture. At its posteroventral extremity the bone articulates with the angular which projects forward into a short, acute notch between the dentary and splenial. The angular-dentary suture is continuous anteriorly with a long splenial-dentary suture that fails to reach the tip of the dentary by only $\frac{1}{8}$ the length of the latter. This anterior portion of the dentary to the exclusion of all other bones, forms the entire tip of the jaw.

TEETH

The teeth are pleurodont, polyphyodont, and homodont. They are slender, being in general five or six times as long as they are wide. Viewed in cross section a separate tooth would appear oval with the compression mediolateral. The base of the tooth is slightly broader than the tip, which is irregularly rounded. The teeth are hollow, each being pierced by a foramen at the median side of its base. The median surface of the teeth is slightly convex. Some show a very slight concavity near the tip. The lateral surface is also convex, more so than the median surface, so that the tip of the bone is sharp.

The number of teeth ranges between 80 and 87. There may be 14 to 17 teeth on each maxilla, the modal number being 16. The premaxilla bears 8 or 9 teeth, and 22 is the only number discovered for each dentary. These three bones are the only dentigerous elements of the skeleton; no evidence of teeth on palatines or pterygoids is present.

Tooth replacement is alternate, new teeth arising between the bases of the teeth of the preceding set.

HYOBRANCHIAL APPARATUS

The hyobranchial apparatus is anterior to the pectoral girdle and ventral of the trachea (Pl. XV, fig. 4). It is composed of 5 parts, two posterior processes, each 1.5 cm. long, 2 lateral processes each 1.7 cm. long, and a single anterior process 1.2 cm. long. Each of these processes is enlarged at its point of articulation with the other processes. The anterior process, the hyoid copula (basihyal), is straight and tapering; the anterior end extends into the tongue. The

lateral process, the hyoid cornu, branches latero-anteriorly for .5 cm. and then curves posteriorly for 1.2 cm. The anterior part is the ceratohyal, the posterior the hypohyal. The curves of the two hyoid cornua are .8 cm. apart. The posterior part of the lateral process extends dorsal to the posterior process in the muscles of the neck and end dorsal to the end of the posterior process. This process is the most slender of the three processes, becoming threadlike after it has curved posteriorly. The branchial cornu (ceratobranchial and epibranchial I) is the thick posterior process, which tapers slightly towards its distal end. It extends latero-posteriorly and gradually curves dorsal into the muscles of the neck. Its distal end is hooked so that it extends directly caudad. The ends of the branchial cornua are 1.4 cm. apart measured in a straight line through the trachea. The epibranchial portion is extremely short.

VERTEBRAL COLUMN

The vertebral column consists of 68 procoelous vertebrae; 6 cervical, 22 thoracic, 1 lumbar and 2 sacral vertebrae comprise the trunk series, while about 37 are present in the caudal region. The convex posterior surface of the centrum of each vertebrae articulates like a ball and socket with the concave anterior surface of the succeeding (posterior) vertebra. There is no zygantrum-zygosphenic articulation. Beneath the postzygapophyses the centrum is slightly excavated to provide the anterior wall of the intervertebral foramen, a passageway for spinal nerves; these foramina become progressively smaller posteriorly throughout the length of the vertebral column. Small subcentral foramina are present on part (middle and posterior portions) of the caudal series of vertebrae but are absent elsewhere on the vertebral column.

CERVICAL VERTEBRAE

There are 6 cervical vertebrae, the posterior three of which bear ribs. The posterior two lack hypapophyses, while the others have them; these processes are situated immediately anterior to the condyle on the posterior face of the vertebrae. The third cervical vertebra bears a short, solid pleurapophysis.

Atlas: The atlas is the ring-like first vertebra which supports the skull by articulation with the occipital condyle. Dorsally, it is composed of 2 flat oblong plates which compose the neural arch and are separable in the midline and are overlapped by a forward projecting process on the neural spine of the axis. Laterally these plates are

constricted, and each bears a short posteriorly directed transverse process. The posterior side of the plate is expanded medially and from the expansion arises a postzygapophysis, situated median to the aforementioned process.

The anterior face of the atlas is obliquely slanted, its dorsal border being posterior to the ventral border. The anterior aspect shows the triangular shaped neural canal with its thin roof, the curved depressed surface, $\frac{2}{3}$ as large as the neural canal, for articulation with the occipital condyle, the lateral downward projecting pleuropophysis near the base of the articulating surface, the median ventral, forward-projecting spine on the hypocentrum. The ventral posterior edge of the hypocentrum is concave and articulates with the pleurocentrum of the atlas fused with the axis.

Axis: The axis is the large second vertebra composed of pleurocentrum, hypocentrum, and the fused pleurocentrum of the atlas which forms the odontoid process. The axis has a large, laterally compressed neural spine which projects forward over the neural arch of the atlas as well as backward like the neural spines of the other vertebrae. Like the atlas, it has a pleurapophysis. In other respects it is similar to the other cervical vertebrae.

THORACIC VERTEBRAE

There are 22 thoracic vertebrae, all articulated with movable ribs. The neural spines become increasingly elevated toward the anterior end of the series. Beneath and slightly posterior to the prezygapophyses is a short diapophysis bearing a costal facet for rib attachment. The facet, particularly on the anterior vertebrae, usually is convex dorsally and concave ventrally. The zygapophyses of the anterior vertebrae are broader than those of the more posterior thoracic vertebrae.

LUMBAR VERTEBRAE

The single lumbar vertebra is anterior to the sacral vertebra. Its neural spine is low. The pleurapophyses are short.

SACRAL VERTEBRAE

There are two separate sacral vertebrae. These have no haemal arches. Their neural spines are lower than the spines of the caudal vertebrae immediately posterior to them. Their pleurapophyses are larger, the anterior ones being thicker than the posterior ones. The ends of these processes join distally (without fusing) to provide a broad articulating surface for a thin cartilaginous (calcified) plate which in turn articulates with the pelvic girdle. These and the

rest of the vertebrae are proportionately less elongate and broader than the caudal vertebrae.

CAUDAL VERTEBRAE

There are 37 caudal vertebrae which decrease in size and sharpness of features posteriorly (Pl. XIV, figs. 7, 8). The caudally projecting, low neural spines diminish in prominence until at the tip of the tail the vertebrae are merely rounded on the dorsal surface. Lateral to and beneath the neural spine are the broad, posteriorly projecting, paired postzygapophyses articulating by their flat undersurfaces with the upper surface of the anteriorly projecting paired prezygapophyses of the vertebra immediately posterior. From the lower half of the anterior end of the vertebra the broad pleurapophyses project anterolaterally, representing the fused rib and rib attachments. The posterior border of these processes forms a slightly oblique angle with the centrum. On the posterior ventral side of the vertebrae immediately in front of the posterior condyle, are two paired facets facing obliquely posteriorly. These articulate with the V-shaped haemal arch which projects posteriorly. The chevrons are thus attached to the centrum, but in the primitive intercentral position. These arches decrease in length posteriorly and disappear on the last four vertebrae.

RIBS

There are 25 pairs of ribs, consisting of 2 parts, the curved dorsal bony section and the ventral cartilaginous section. There are 5 anterior thoracic ribs which attach to the sternum (on the 7th to the 11th vertebrae inclusive). They are about $\frac{3}{4}$ cartilaginous, while the following ribs are provided with cartilaginous sections decreasing in size posteriorly; the last ones have only a small tip. There are 3 pairs of cervical ribs; they are compressed anteroposteriorly, rather strongly expanded at the distal bony tip, and are less than half the length of the anterior thoracic rib; the cartilaginous portion of the anterior rib is about $\frac{1}{4}$ the length of the bony portion, while that of the last is nearly equal to the length of the bony portion. The cartilaginous portions are calcified, as indicated by the heavy staining with alizarin red.

No ventral ribs (either gastralia or abdominal ribs) are present.

PECTORAL GIRDLE

The pectoral girdle is an anterior ventral structure supporting the forelimbs at the glenoid fossae, and articulating with the sternum. (Pl. XV, figs. 3, 5, 6.) It is composed of 7 elements: suprascapula, scapula, coracoid, precoracoid, epicoracoid, interclavicle, and clavicle, of which the suprascapula and epicoracoid are cartilaginous. The unpaired interclavicle and paired clavicles are the median elements by which the relatively freely movable, overlapping halves of the remainder (scapulocoracoids) of the girdle articulate with each other and with the sternum.

Interclavicle: The interclavicle is a single, slender, anchor-shaped bone applied to the ventral surface of the pectoral girdle and the sternum. It consists of 4 narrow processes. The longest is a flattened, median posterior process 1.1 cm. in length, which articulates along its sides with the epicoracoid, and underlies the anterior half of the midline of the sternum. It joins anteriorly a pair of lateral processes, 6.3 mm. in length, which form the "hooks" of the anchor, curving diagonally posteriorly and paralleling the clavicles. The anterior process is very short (1 mm.) and overlies the median ventral ends of the clavicles; it is the only portion of the interclavicle which extends dorsal to another portion of the girdle.

Clavicle: The clavicle is the slender anterior bone of the girdle. It is paired and meets its mate in a point on the midline of the girdle; at that point they immediately overlap and completely conceal in ventral view the anterior process of the interclavicle. The two clavicles diverge from the median line in a broad V with the apex directed anteriorly. After extending laterally for 7.5 mm., parallel to the interclavicular "hooks" the bone curves dorsally and slightly caudad for a nearly equal distance (6.5 mm.) The clavicles articulate with the interclavicle only at its anterior apex. In normal position, the clavicles are overlapped at their apices on the dorsal side by the broad anterior ends of the epicoracoids. The dorsal tip of each clavicle articulates with the suprascapula. This articulation is of great importance, functioning as the swivel from which the scapulocoracoids rotate in a narrow arc, guided by the groove on the front edge of the sternum.

Epicoracoid: The epicoracoid forms the median posterior and most of the anterior (as far laterally as the scapula) borders of the movable halves (scapulocoracoids) of the pectoral girdle. The ventral ends of the scapulocoracoids lie dorsal to the anterior end of the

sternum, and to the clavicles and interclavicle. The anterior end of the epicoracoid normally articulates broadly with the dorsal surface of the clavicles near their median ends; the anterior median edges overlap each other (the left over the right) and the outwardly curving posterior edges appear normally to slide in a groove on the outer anterior edge of the sternum. The element borders the coracoid bone along its entire median limit, and becomes broader anteriorly, where it forms the anterior margins of the coracoid fenestra and meets the precoracoid bone lateral to that fenestra. A narrow extension of the epicoracoid extends from that point to the antero-medial corner of the scapula, thus forming the anterior border of the scapulocoracoid foramen.

All of the epicoracoid is composed of calcified cartilage except for a narrow border of hyaline cartilage on the medial edge of the element.

Coracoid and Precoracoid: The coracoid lies lateral to the epicoracoid; it is bordered by the latter in all directions except laterally. It forms the lateral border of the ventral part of the girdle from the glenoid fossa posteriorly. From its posterior union with the epicoracoid the lateral border of the coracoid extends anteriorly to the glenoid fossa, having a large indentation in the mid-point between its posterior limit and the fossa. From the midline of the fossa the suture separating the coracoid and the scapula supposedly extends anteriorly to the median posterior border of the coracoscapular fenestra although this suture cannot be distinguished. The coracoid then extends forward in a narrow tongue, called the precoracoid, to meet a posteriorly directed tongue of the epicoracoid. Together these processes form a separating bridge between the coracoscapular fenestra and the coracoid fenestra. Posterior and median to the precoracoid is the supracoracoid foramen. Median to the precoracoid, the coracoid curves posteriorly and then anteriorly, meeting the epicoracoid and forming the posterior and most of the lateral and median borders of the coracoid fenestra.

Scapula: The scapula is the relatively thick, dorsally directed, lateral bone of the girdle. It is narrow in width and thickened where it meets the coracoid in the glenoid fossa. From here it expands gradually as it extends anterodorsally. The bone forms the posterior and lateral borders of the coracoscapular fenestra and part of the posterior edge of the girdle, and is indistinguishably fused with the coracoids. Its dorsal edge is broadly expanded and articulates with the suprascapula. Its anterodorsal edge closely approaches the

dorsal portion of the clavicle. Near the dorsal margin of the glenoid fossa is the small supraglenoid foramen.

Suprascapula: This is the large, flat, rounded element on the most dorsal part of the girdle. It articulates with the dorsal edge of the scapula and with the median side of the dorsal process of the clavicle. It arches over the ribs toward the vertebral column. Except for a narrow vertebral border of hyaline cartilage the element consists entirely of calcified cartilage.

STERNUM

The sternum is the large, sheet-like ventral element which supports the ribs (Pl. XV, figs. 3, 5). It articulates with the interclavicle, epicoracoid, and ribs. The posterior edge of the sternum forms a right angle with the apex directed posteriorly. It is free from articulations except with the ribs, with which there are four cartilaginous attachments of which the median is branched, or sometimes there may be 5 separate rib attachments. This edge appears scalloped with the rib attachments on the crests of the scallops. The anterior edges form a right angle on either side with the posterior edge. The edge is deeply grooved for articulation with the epicoracoid. This anterior edge does not continue medially to complete a square but curves gently anteriorly, enclosing a rather broad anterior process. A large notch in this process receives part of the interclavicle, the posterior third of which emerges ventrally from the notch and extends posteriorly in contact with the ventral surface of the sternum.

The sternum consists of calcified cartilage, as is indicated by its reaction to alizarin red.

FORELIMB

Humerus: The proximal bone of the forelimb is 1.7 cm. long. It is a narrow rounded bone (Pl. XVI, fig. 4) expanded at both ends to provide articulation with the pectoral girdle and the radius and ulna. The proximal end is expanded horizontally and compressed and bent slightly upwards from the level line of the bone. Viewed dorsally this expansion appears fan-shaped. On the median half of the curve of the fan it is expanded into a surface for articulation with the pectoral girdle. Lateral to this surface the curve of the fan indents. From the ventral view this expansion appears depressed in the middle with a ventrally projecting knob on the lateral edge.

The distal end of the bone is expanded and compressed vertically at an angle of 70° to the compression of the proximal end. The

compressed part of the bone spreads wider ventrally than dorsally. On the lateral side of this compression are two knobs, the larger dorsal one, the radial condyle, for articulation with the radius, the smaller ventral one, the ulnar condyle, for articulation with the ulna. Immediately proximal to the larger condyle is a groove with a nutritive foramen. A supracondyloid foramen occurs lateral to the radial condyle.

Radius: A thin elongated bone forming the preaxial half of the distal part of the forelimb (Pl. XVI, fig. 4). It is 1.1 cm. long. It is expanded at its proximal end to form a cuplike articulation with the larger knob on the humerus. On the side of the bone posterior to this socket the radius articulates with the side of the ulna. The distal end has a small expansion for articulation with the radiale of the wrist.

Ulna: The ulna is a thin elongated bone, slightly thicker than the radius, forming the postaxial half of the distal part of the forelimb (Pl. XVI, fig. 4). It is 1.3 cm. long. The proximal end is expanded and indented to articulate with the smaller condyle on the humerus. The distal part of the bone is expanded into a malleolus which articulates with the ulnare and the intermedium of the wrist. The posterior edge of the bone next to this malleolus is flattened for articulation with the pisiform. No ulnar patella is present.

Wrist Bones: The wrist bones are small, irregularly shaped little bones serving to connect the radius and ulna with the phalanges (Pl. XVI, fig. 8). They consist of ten elements, including the small lateral pisiform (Pl. XVI, fig. 4), articulating with the ulna and the ulnare; the large cuboid ulnare, articulating with the ulna, the pisiform, the intermedium, a centrale, and carpalia V and IV; the small intermedium, articulating with the ulnare, radiale, centrale and ulna; the elongate radiale, articulating with the radius, the intermedium, carpal I, metacarpal I. and centrale; the small cuboid centrale articulating with the radiale, intermedium, ulnare, carpalia I, II, and III; the respective carpalia, articulating with the corresponding metacarpals.

Digits: Metacarpal III is the longest, IV is nearly as long, and II, V and I are succeeding smaller. The formula for the phalanges is 2, 3, 4, 5, 3. The phalanges articulate with each other by condyles, the anterior end of each phalanx being knoblike and the posterior end depressed. The proximal end of each phalanx extends under the distal end of the preceding one. All the digits are clawed. A small sesamoid bone is present at the dorsal base of each claw.

THE PELVIC GIRDLE

The pelvic girdle acts as a means of attachment between the hind limbs and the vertebral column by union in a cartilage plate of the ilium with the two sacral ribs, and by articulation of the femur in the imperforate acetabulum. It is composed of 5 elements (Pl. XV, fig. 2; Pl. XVI, fig. 7): pubis, ilium, ischium, hypischium, and epipubis. The latter two are composed of calcified cartilage, the others of bone.

Pubis: The pubis is the anterior bone of the girdle. From the lateral edge of the girdle it is directed ventrally and forward at an angle of 20° to the perpendicular on the vertebral column. Its ventral side is convex, its dorsal side slightly concave. It does not meet its mate in the midline but is separated from it by the small cartilaginous epipubis. The anterior end is expanded and rounded slightly. It is overlapped at its tip by the epipubis so that it does not form the anterior limit of the girdle. At its lateral limit, the pubis sends ventrolaterally a wing terminated by a knob-like thickening. Posterior to this wing the bone is indented on its lateral side and then protrudes again immediately in front of the sharp edge of the acetabulum. The median edge curves from its laterally directed course and turns posterior just median and anterior to the acetabulum. The curve of the pubis is continuous with the curve of the anterior border of the ischium and forms with it the anterior, lateral, and posterior border of the ischiopubic fenestra. If the acetabulum is imagined to be triangular with its longest base ventral, the suture of the pubis with the ischium in the acetabulum can be said to bisect the ventral base of the triangle and the suture with the ilium to bisect the anterior side of the triangle. The suture with the ischium can be traced on the ventral side of the girdle from the acetabulum to the place where the curve of the ischiopubic fenestra is sharpest on its lateral edge. Dorsally neither the suture with the ischium nor with the ilium can be distinguished. The obturator foramen pierces the pubis on its ventral side in the middle of the bone between the suture with the ischium and the lateral wing on the pubis.

Epipubis: A small, triangular, cartilaginous element wedged between the anterior ends of the two pubes. The sides of the triangle are concave so that the apices are long and tapering. Two of these apices overlap the anterior edges of the pubes, the third is directed posteriorly between the pubes. Here it is joined in life to the hypo-

ischium by the puboischiadic ligament forming the median border of the two ischiopubic fenestrae.

Ischium: The median posterior pair of bones of the pelvic girdle. From its lateral edge it is directed slightly ventroanteriorly. It is a broad bone, expanded at both ends, its curved anterior border forming the posterior border of the ischiopubic fenestra. It is separated from its mate of the opposite side by the cartilaginous hypoischium. At $\frac{1}{3}$ of the distance from the lateral limit along the posterior border, the ischium sends posteroventrally a broad process. The bone is flat except for the thickening at the acetabulum. Its suture with the pubis bisects the ventral border of the acetabulum and continues on the ventral side of the girdle to the place where the lateral border of the ischiopubic fenestra has its sharpest curve. Dorsally this suture cannot be distinguished. The suture with the ilium bisects the posterior border of the acetabulum and cannot be seen dorsally.

Hypoischium: This is a cartilaginous element wedged between the two ischia and extending forward to form the median border of the ischiopubic fenestrae with the puboischiadic ligament. It also extends backward in a narrow tapering process for a distance equal to the entire antero-posterior length of the girdle. The anterior process is broad between the anterior parts of the two ischia and tapers sharply to a point joining the ligament.

Ilium: The ilium is the narrow, posterior, dorsal bone of the pelvic girdle joining the sacral ribs. It articulates anteriorly with the pubis and the ischium in the acetabulum. From this socket it curves slightly dorsad and shortly continues directly caudad for the rest of its length, tapering slightly at its posterior end. Its dorsal edge has a small rough ridge just behind the acetabulum. The articulation with the broad ends of the sacral ribs occurs on the medial half of the middle $\frac{1}{3}$ of the length of the bone.

HIND LIMB

Femur: The long proximal bone of the hind limb (it is 1.9 cm. long) articulating with the pelvic girdle and the fibula and tibia (Pl. XVI, fig. 5). At its proximal end it is compressed laterally. On the median side of this compressed region is a large anteriorly projecting knob, the head, for articulation with the pelvic girdle. Lateral and posterior to the head is the trochanter, a lesser knob for muscle attachment. On the ventral side of the bone, between the trochanter and the head, the femur is slightly depressed. The shaft

of the bone curves slightly (ventrally) from the proximal to the distal end.

At the distal end the bone curves slightly laterally and expands to articulate with the tibia and fibula. At this point occurs an extraordinary complement of 6 sesamoid bones (Pl. XVI, figs. 1, 3). On the anterior side of the femur, near the beginning of the expanded part, there is a smooth area where the small round scalelike patella tibialis is attached. On the anterior side also, between the femur and the tibia and fibula, are wedged three small interarticular sesamoid bones. These three elements seem to be attached between the long bones to two more, similar, sesamoid elements wedged into the joint on its posterior side. One or two of these 5 elements may represent the fibular interarticular sesamoids. The posterior side of the femur presents two scroll-like condyles. The fibula articulates with the smooth lateral side of the larger dorsal condyle. The tibia articulates with the rounded edge of the smaller ventral condyle and the whole distal edge of the larger condyle. Proximal to the midpoint of the larger condyle the femur is slightly depressed for a short distance.

Tibia: The tibia is the larger of the two bones of the distal end of the hind limb (Pl. XVI, fig. 2). It is 1.3 cm. long. It is broadened for about $\frac{1}{3}$ of its length at the proximal end. Here it expands greatly to articulate broadly with the femur. The posterior edge of this articulating surface is indented slightly to articulate with the side of the fibula. The shaft of the tibia curves slightly caudad.

The distal end of the tibia is expanded to only $\frac{1}{2}$ the width of the proximal end. The tip is cupped to provide articulation with the astragalus. A small anteroventral projection of the tip extends along the side of the astragalus.

Fibula: The fibula is the smaller bone of the distal part of the hind limb (Pl. XVI, fig. 2). It is 1.3 cm. long. The shaft of the bone curves slightly caudad. The proximal end is expanded slightly and articulates on its side with the side of the large dorsal condyle of the femur and with the notch in the end of the tibia. The distal end is also slightly enlarged and has an oblong, slightly convex surface for articulating with the calcaneum.

Ankle Bones: The astragalus and calcaneum are fused (the astragalocalcaneum of Schaeffer). The calcaneum is the posterior element, the larger of the two, and may be distinguished from the astragalus by an indentation between the two articulating facets, the calcaneum articulating with the fibula and the astragalus artic-

ulating with the tibia (Pl. XVI, fig. 6). If the face of the oblong facet of the calcaneum is observed in direct view, the face of the larger round astragalus facet by comparison is slanted slightly more dorsal and anterior. The ventral side of the fused bone is slightly concave, except for a lump raised on the distal edge of the calcaneum. The distal border of the fused bone is wavy and articulates with metatarsals I and II, and tarsalia 3 and 4.

The tarsalia are only two in number. IV is an irregularly shaped element, about the size of the calcaneum, wedged in between the fused astragalus and calcaneum, the metatarsalia IV and V, and tarsale 3. Tarsale 3 is represented by small element closely applied to metatarsal III. This element bends over the proximal end of metatarsal II so that it is oblique to the straight line of metatarsal III. Tarsalia I and II appear to be fused to the proximal ends of the corresponding metatarsalia.

Digits: The digits are five in number, I being the smallest and the lengths increasing progressively to IV which is the longest digit (Pl. XVI, fig. 6). V is intermediate in length between I and II. Metatarsal V is out of line with the other metatarsals and is peculiarly modified. It is expanded at its proximal end so that it comes in contact with the posterior face of tarsale IV, reaches the astragalocalcaneum, and underlies metatarsal IV. It is also much shortened. On the ventral side near its distal end, the bone has a small protuberance. The phalangeal formula is 2, 3, 4, 5, 4. All the digits are clawed. A small sesamoid bone occurs at the dorsal base of each claw.

DISCUSSION

Little of strikingly unusual nature was discovered in the skeleton. Perhaps the most noteworthy discovery was the presence of otoliths, which heretofore have not been recorded above amphibians and are definitely not present in the related genera *Heloderma* and *Gerrhonotus*. They were found on both sides in all three skulls examined for them, in which they could best be seen through the fenestra ovale; they lie loose in the otic capsule, where they roll about freely as the skull is tilted at various angles.

Apparently unusual also are the palpebral and sclerotic bones. The former are not recorded in any other lizards, and the latter in very few (e. g., *Lacerta*).

We were at first inclined to regard the astonishing complement of 6 sesamoid bones at the knee as another unique characteristic,

but a like number was discovered in both *Gerrhonotus* and *Heloderma*, in each of which the arrangement is very much like that of *Xenosaurus*.

While well known in many groups of lizards, the function of the curious incisive process on the premaxilla remains unknown. In *Heloderma* it is reinforced by a pair of like processes on the anterior tip of the prevomer. The structure is of such wide occurrence and constancy that some important function for it is suggested.

Subcentral vertebral foramina, said by Camp to be absent in the higher Anguimorpha, are present in the anterior caudal vertebrae not only of *Xenosaurus* but also *Gerrhonotus*. They are absent elsewhere in the vertebral column. Their presence in *Heloderma* could not be determined in the specimen available.

RELATIONSHIPS OF XENOSAURUS

In tabular form the contrasting characters of *Xenosaurus*, *Heloderma* and the Anguidae are summarized. No mention has been made of characters similar in the three groups.

It is clear that *Heloderma* is very widely different from those forms with which it is compared. The grooved teeth; the curious ventral fusion of the frontals below the olfactory lobe of the brain; the absence of the postorbital bone and supratemporal fossa, and very great reduction of the squamosal; the presence of 8 cervical ribs and 2 lumbar vertebrae; the absence of the scapulocoracoid and coracoid fenestrae; the complete separation of the pelvic bones; the median cartilaginous plate between the bony lateral halves of the sternum; the exclusion of the maxilla from the infraorbital fossa and resultant contact of ectopterygoid and palatine bones; absence of a parietal foramen; contact of prefrontal and postfrontal; the short stapes; the separate surangular; the absence of cervical hypapophyses; the presence of vomerine incisive processes; the contact of pterygoid and jugal; and the curious dorsal trunk scutellation, among other lesser peculiarities, thoroughly validate the segregation of the genus as a separate family. It is far less closely allied to either *Xenosaurus* or the Anguidae than the latter two are to each other.

TABLE OF COMPARISONS

<i>Feature</i>	<i>Xenosaurus</i>	<i>Heloderma</i>	<i>Anguidae</i>
Nasals	paired	paired ¹	paired
Frontals	fused	paired	fused or paired
Ventral groove on frontal	open ventrally	closed ventrally	open ventrally
Frontal and premaxilla	very narrowly contact ventrally, separated dorsally	separated widely	widely separated to broadly in contact
Parietal foramen	present	absent	present
Maxilla and premaxilla	clearly in contact	not or barely in contact	clearly in contact
Septomaxilla	with a sharp dorsal ridge	not prominently ridged	not prominently ridged
Prefrontal and postfrontal	no contact	narrowly in contact dorsally ²	no contact
Postorbital	fused with postfrontal	absent	separate
	contacts squamosal	separated from squamosal	contacts squamosal
Palpebral	paired	absent	absent
Sclerotics	about 20	absent	absent
Jugal	broadly contacts squamosal	broadly separated from squamosal	narrowly or broadly separated from squamosal
Supratemporal fossa	present	absent	present
Supratemporal arcade	very well developed	absent	weak
Tabulare	very small	enlarged, flattened	moderate
Squamosal	very large, broad	extremely minute, vestigial ³	slender
	contacts parietal, jugal	contacts neither	contacts neither

¹ According to Shufeldt the nasals are fused, but Camp and Gilmore both correct this statement.

² Gilmore states that the contact of prefrontal and postfrontal excludes the frontal from the orbital border, but this is not so in the specimen examined. In it a narrow projection of the frontal underlies the common suture of the prefrontal and postfrontal, and forms a short part of the supraorbital line.

³ Generally considered absent, an extremely small nodule lying on the lateral surface of the suture between the tabulare and quadrate, in the single specimen examined, is interpreted as the squamosal. There are two other bony nodules distal to the squamosal on the edge of the quadrate, whose identities are not known.

<i>Feature</i>	<i>Xenosaurus</i>	<i>Heloderma</i>	<i>Anquidæ</i>
External naris	not bordered by osteoderms	bordered in part by osteoderms	not bordered by osteoderms
Prevomer	no incisive process	an incisive process	no incisive process
Palatine and ectopterygoid	widely separated	generously overlapping	widely separated
Posterior palatine vacuity	bordered by maxilla	not bordered by maxilla ⁴	bordered by maxilla
Pterygoid	no contact with jugal toothless	barely contacts jugal toothed	no contact with jugal toothed or not
Ectopterygoid	reaches labial border	does not reach labial border	does not reach labial border
Carotid fossa	shallow	very shallow	very deep
Sphenoid	separate in young adults	fused with otocephital	separate in young adults
Otoliths	present	absent	absent
Stapes	very nearly reaches tympanum	does not reach quadrate level	nearly reaches tympanum
Surangular	fused with articular and prearticular	separate	fused with articular and prearticular
Teeth	blunt, bases not swollen, smooth	sharp, elongate, reduced in number, bases swollen, many grooved on anterior medial edge	blunt, bases not swollen, smooth
Branchial arch II	no vestiges	no vestiges	epibranchial present
Cervical vertebrae ⁵	6	8	8
Cervical hypophyses	present	absent	present
3rd cervical vertebra	ribless	ribless	ribbed
Sternal ribs	5	4	5
Lumbar vertebrae ⁶	1	2	0

4. Gilmore states that the maxilla forms a part of its border, but this is apparently a lapsus.

5. For convenience all vertebrae in the neck region whose ribs, if any, fail to reach the sternum are considered cervical vertebrae.

6. Posterior trunk vertebrae without ribs (or with the ribs fused) are regarded as lumbar vertebrae.

Feature	<i>Xenosaurus</i>	<i>Heloderma</i>	<i>Anguidae</i>
Scapulocoracoid and coracoid fenestrae, and distinguishable precoracoid	present	absent	pres. nt
Clavicle	unforked	unforked	forked or unforked
Interclavicle	subcruciform	rod-like	cruciform
Sternum	cartilaginous	halves bony, separated by a median cartilage plate	cartilaginous
Epicoracoid	reaches scapula	fails to reach scapula	reaches scapula
Intermedium	large	very small ⁷	extremely minute
Knee sesamoids	6	at least 4, probably 6	6
Pelvic bones	fused at acetabulum	entirely separate	fused at acetabulum
Tympanum	concealed	exposed	exposed
Dorsal trunk osteoderms	absent	present	present
Dorsal scales	minute, granular	large, nodular	large, imbricate
Head scales	small, irregular	irregular	regularly arranged

Characters peculiar to *Xenosaurus*, within the limits of the present comparisons, are: the unique otoliths, sclerotic bones and palpebrals; the very strong postorbitosquamosal arcade, with articulation of the squamosal with the jugal and parietal; the subcruciform interclavicle; the large intermedium; the penetration of the ectopterygoid to the external, lateral labial border, at the maxillo-jugal suture; concealed tympanum; and the curious granular, dorsal body scales lacking osteoderms.

Characters peculiar to the Anguidae include an extremely deep carotid fossa; absence of lumbar vertebrae and presence of ribs on the 1st postaxial vertebra; cruciform interclavicle; the presence of the epibranchial of branchial arch II; large, imbricate dorsal trunk scales; and distinctive head plates.

The retention of the family Xenosauridae, distinguished from its closest relatives the Anguidae and Helodermidae, appears to be amply justified by the characters differing between the three groups.

7. Generally said to be absent, the intermedium is clearly present, though small, in the skeleton examined. It is present although extremely minute in a single specimen of *G. imbricatus* examined for it. Camp records its existence in both these genera, but erroneously says it is absent in *Xenosaurus*.

The family obviously is most closely related to the Anguidae. All three families appear to have been derived from some common stock, rather than any one from the other. Retaining the least number of unique primitive characters is *Heloderma*, with only the separate surangular and pelvic bones in that category. Its specializations are many and except for the reduction of the postorbitosquamosal arcade, do not follow the line of evolution indicated by the Anguidae. Of course they likewise do not parallel the Xenosauridae, which is quite primitive in many respects. The latter family possesses the most primitive postorbitosquamosal arch of the three groups, and likewise the large intermedium is primitive. Yet the curious scutellation, fusion of the surangular, and the development of sclerotic and palpebral bones, cannot be considered primitive.

The Anguidae possesses more unique primitive characters than either of the other families. Among them are the possession of a portion of arch II, large imbricate dorsal scales, absence of lumbar vertebrae, presence of ribs on the 3rd cervical vertebra, and presumably the cruciform interclavicle. Yet the reduction of the postorbitosquamosal arch is greater than in *Xenosaurus*; it has the greatest development of the carotid fossa; and it is not as primitive as *Heloderma* (but like *Xenosaurus*) in the distinctness of the surangular and pelvic bones.

It may be concluded that the Anguidae is the most primitive family of the Anguioidea, but that the several members of that superfamily are not to be derived from the Anguidae directly, at least as that family is now known, but from a common stock probably not greatly different from its primitive members.

CONCLUSION

Otoliths are recorded for the first time from reptiles, and palpebral bones for the first time in lizards. The family Xenosauridae is regarded valid and more closely related to the Anguidae than to any other family. The "paroccipital" of Camp and Gilmore's *Melanosaurus maximus* is regarded as identical with an element in *Xenosaurus* interpreted as a separately ossified epiphysis of the paroccipital process.

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PLATE XI

FIG. 1. *Xenosaurus grandis* (Gray), dorsal view. Cuautlapan, Veracruz.
From the E. H. Taylor—H. M. Smith collection. Somewhat reduced.

FIG. 2. Same, ventral view.

PLATE XI

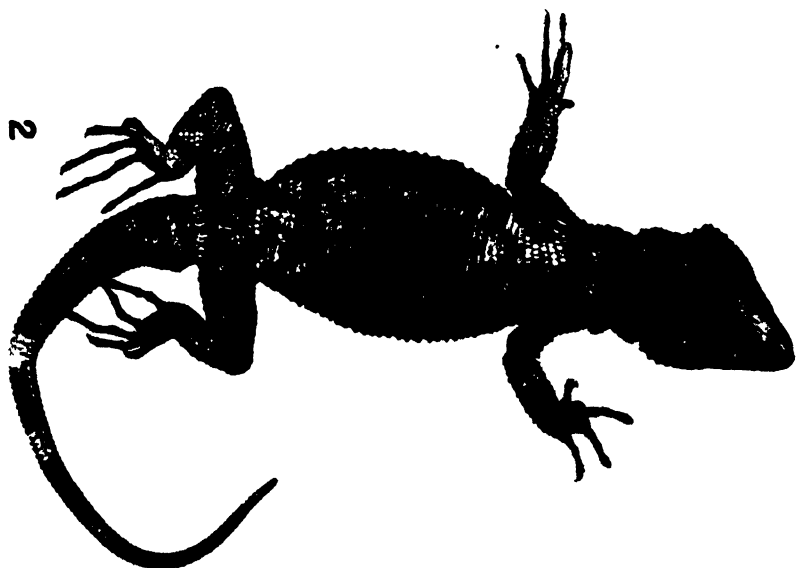


PLATE XII

Skull of *Xenosaurus grandis* (Gray), much enlarged.

FIG. 1. Ventral view.

FIG. 2. Dorsal view.

PLATE XII

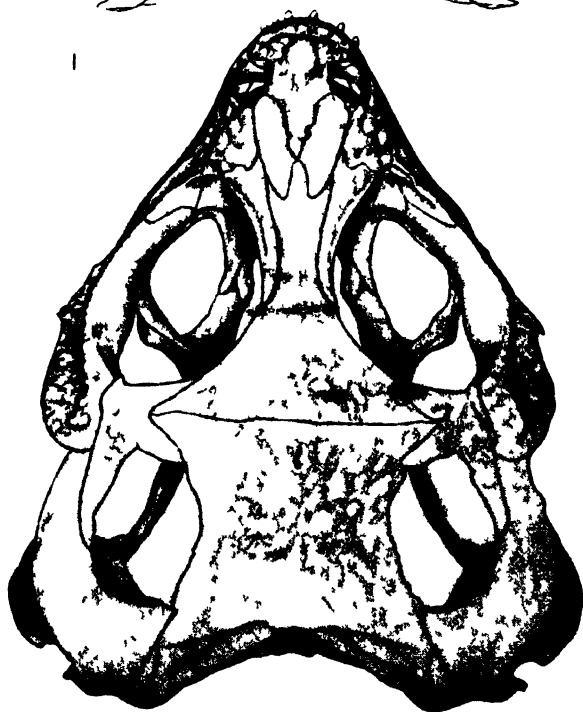
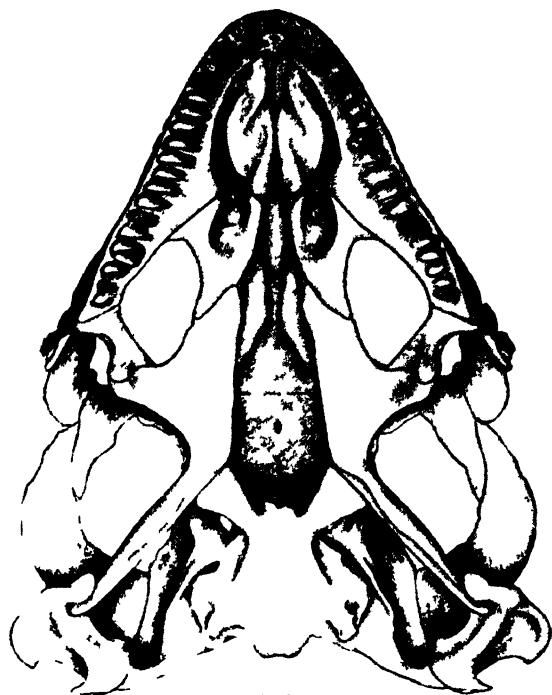


PLATE XIII

Skull of *Xenosaurus grandis* (Gray) much enlarged.

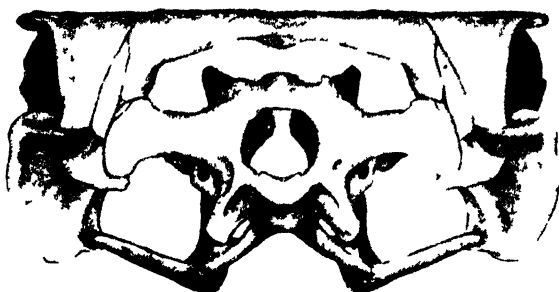
FIG. 1. Posterior view of skull.

FIG. 2. Median view of lower jaw.

FIG. 3. Outer lateral view of lower jaw.

FIG. 4. Skull lateral view.

PLATE XIII



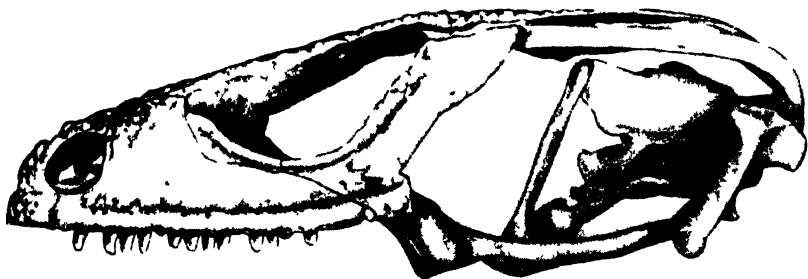
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PLATE XIV

FIG. 1. Dorsal view of maxilla, septomaxilla and associated bones; premaxilla, nasal and frontal removed. Labels: *lac*, lacrimal; *m*, maxilla; *pref*, prefrontal; *prev*, prevomer; *septm*, septomaxilla.

FIG. 2. Tabulare, dorsal view.

FIG. 3. Otooccipital, anterior view. Labels: *ab f*, abducens foramen; *att t c*, point of attachment of trabecula communis; *basio t*, basioccipital tubera; *f end*, foramen endolymphaticum; *i c f*, internal carotid foramen; *p a f*, posterior acoustic foramen; *paroc pr*, paraoccipital process; *pro*, prootic; *pt pr*, pterygoid process; *sph*, sphenoid.

FIG. 4. Frontal, ventral view. Surface labelled: *con pref*, contacts prefrontal; *und n*, under the nasal; *und p m*, extends under premaxilla.

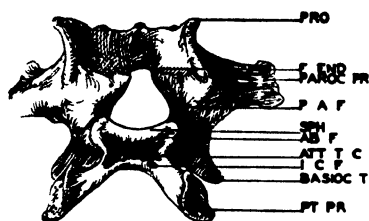
FIG. 5. Parietal, ventral view. Labels: *a r*, anterior ridge; *con eppt*, contacts epipterygoid; *p a*, point of attachment of processus anterior of synotic tectum; *par f*, parietal foramen; *p r*, posterior ridge.

FIG. 6. Otooccipital, dorsal view. Labels: *ab f*, abducens foramen; *att t c*, point of attachment of trabecula communis; *cp*, carotid fossa; *p a*, point of attachment of processus anterior of synotic tectum; *paroc pr*, paraoccipital process; *p n f*, vidian canal; *pt m*, pterygoid process; *sph-otoc*, sphenoid-otooccipital suture; *supraoc*, supraoccipital; *tm*, point of attachment of occipital.

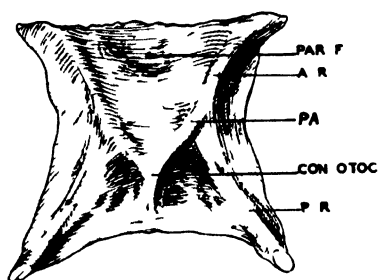
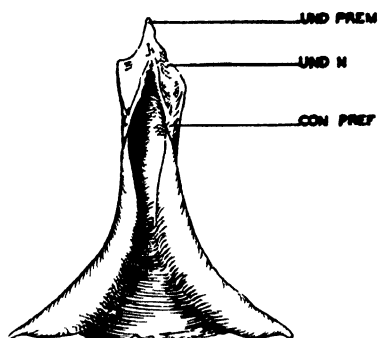
FIG. 7. Two basal caudal vertebrae, the first with its chevron; ventral aspect. Labels: *cen*, centrum; *ch*, chevron; *pl*, pleurapophysis; *postz*, postzygapophysis; *prez*, prezygapophysis; *sub f*, subcentral foramen.

FIG. 8. Same as fig. 17, dorsal aspect. Labels: *ne sp*, neural spine; other labels as for fig. 17.

PLATE XIV



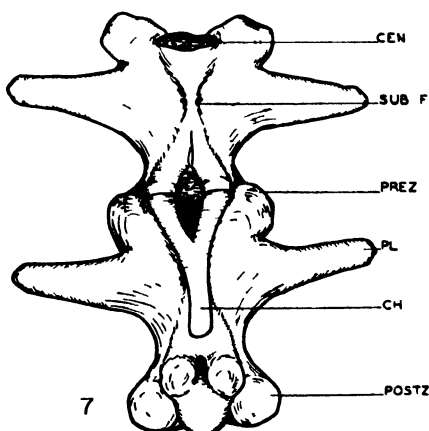
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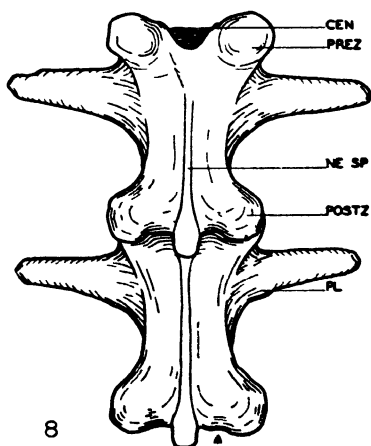
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PLATE XV

FIG. 1. A phantom figure of the cranium. Blackened areas are heavily stained; stippling indicates lighter staining; short lines indicate membranes. Labels: *fo*, optic foramen; *is*, interorbital septum; *ju*, jugal; *of*, optic fenestra; *oo*, otooccipital; *pa*, processus ascendens; *pac*, pila accessoria; *pao*, pila antotica; *pas*, processus anterior of synotic tectum; *pm*, pila metoptica; *ps*, planum suprasedale; *sin*, subiculum infundibuli; *tc*, trabecula communis; *tm*, taenia marginalis; *tmc*, taenia medialis.

FIG. 2. Pelvic girdle, lateral aspect. Labels: *acet*, acetabulum; *hypo*, hypopisium; *il*, ilium; *is*, ischium; *pub*, pubis.

FIG. 3. Pectoral girdle and sternum, ventral aspect. Evenly dotted areas are of calcified cartilage; diagonal lines indicate bone; and irregular dots indicate hyaline cartilage. Shading is the intent of the darker areas; for example, both portions of the girdle overlie the sternum (in this aspect), while the right half of the girdle overlies the left half, etc.

FIG. 4. Hyobranchial apparatus. Labels: *cer*, ceratohyal; *hyp*, hypohyal; *br*, branchial cornu (ceratobranchial); *e*, epibranchial I, *hy cop*, hyoid copula.

FIG. 5. As in fig. 19, dorsal aspect. Shading indicates the same as in fig. 19.

FIG. 6. Right half of pectoral girdle, in lateral aspect. Shading as in fig. 19.

PLATE XV

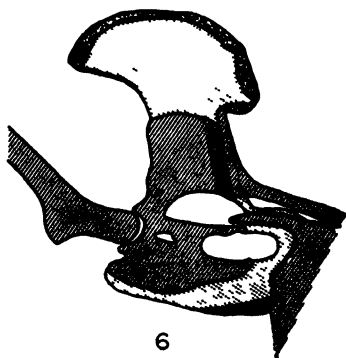
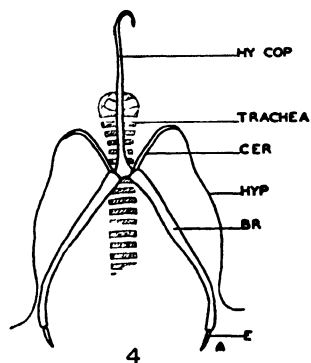
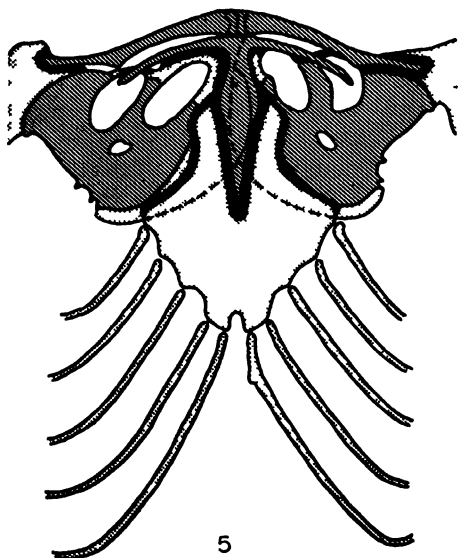
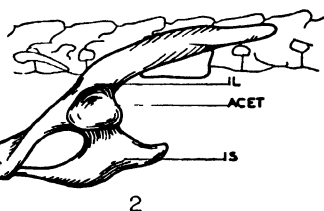
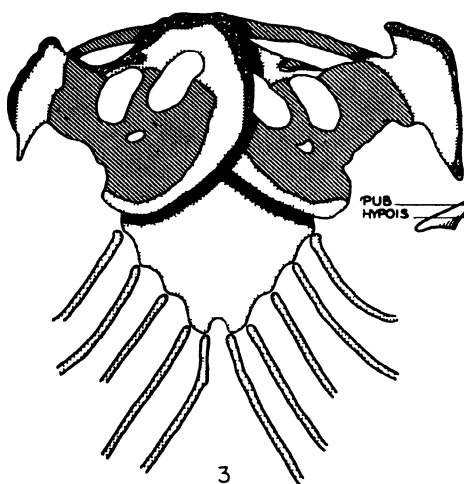
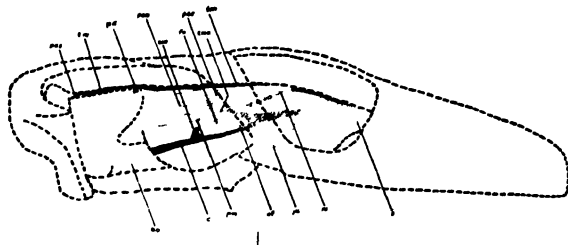


PLATE XVI

FIG. 1. Knee joint, in dorsal aspect. Labels: *fe*, femur; *fib*, fibula; *ses*, sesamoid; *t*, tibia.

FIG. 2. Posterior aspect of left fibula and left tibia.

FIG. 3. Knee joint, somewhat separated in dorsal aspect. Labels: *fe*, femur; *d ses*, dorsal sesamoids; *v ses*, ventral sesamoids; *t*, tibia.

FIG. 4. Foreleg showing dorsal aspect of humerus (*h*), ulna (*u*), radius (*r*), and pisiform (*pis*).

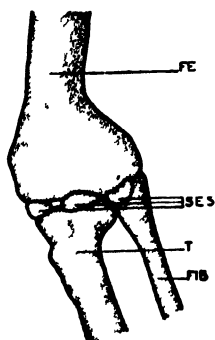
FIG. 5. Left femur, dorsal aspect and anterior aspect.

FIG. 6. Left foot, dorsal aspect. Labels: *ast*, astragalo-calcaneum; *ta*, tarsalia.

FIG. 7. Pelvic girdle, ventral aspect; cartilage stippled. Labels: *epub*, epipubis; *hypo**is*, hypischium; *il*, ilium; *is*, ischium; *pub*, pubis; *sac v.* sacral vertebra.

FIG. 8. Left hand, dorsal aspect. Labels: *car*, carpalia; *ct*, centrale; *int*, intermedium; *pis*, pisiform; *r*, radius; *rd*, radiale; *u*, ulna; *ul*, ulnare.

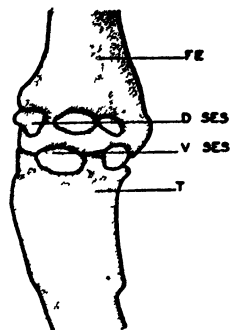
PLATE XVI



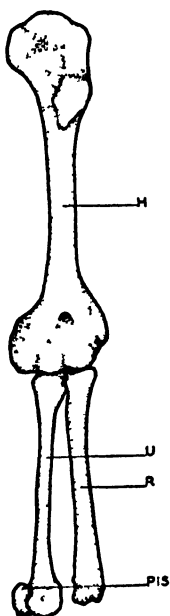
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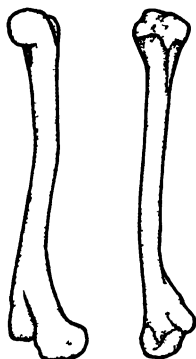
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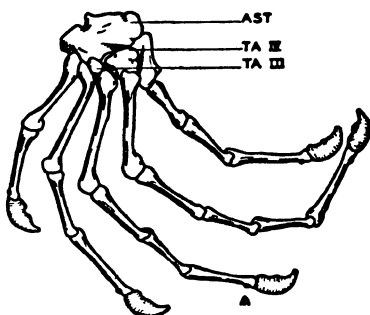
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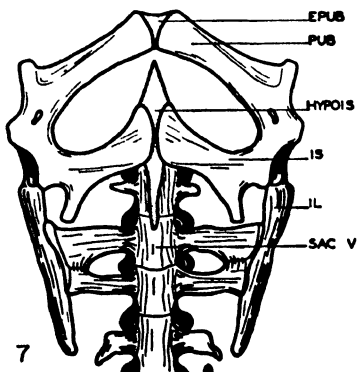
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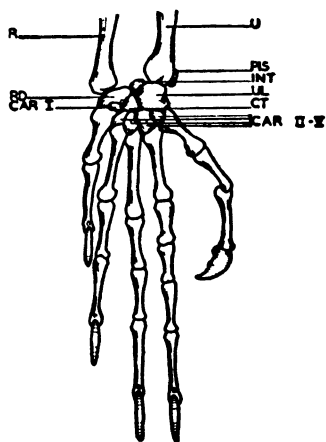
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THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

VOL. XXXI, pt. II.]

NOVEMBER 1, 1947

[No. 13

Comments on Ceylonese Snakes of the Genus *Typhlops* with Descriptions of New Species

By EDWARD H. TAYLOR

ABSTRACT: Five new species of the small blind snakes of the genus *Typhlops* are described from the Island of Ceylon. These are *Typhlops lankaensis*, *T. violaceus*, *T. malcolmi*, *T. tenebrarum*, and *T. veddae*. Five other forms are reported also. These are *Typhlops braminus*, *T. porrectus*, *T. mirus*, *T. ceylonicus*, and *T. leucomelas*.

THE most recent review of the snakes of Ceylon, is included in a recent volume by Malcolm Smith, which deals with the fauna of India and southeastern Asia.* In this entire region 19 species belonging to the genus *Typhlops* Oppel are recognized, one of the species being represented by two subspecies. Of the 19 species, five are reported from the island of Ceylon. Three of these have not been found elsewhere and are presumed to be endemic. The species are:

1. *Typhlops mirus* Jan, a species described about 85 years ago, but known from very few specimens, and from the single definite locality—Peradeniya. Endemic.
2. *Typhlops leucomelas* Boulenger. Known from two specimens. Endemic.
3. *Typhlops ceylonicus* Smith. The type is the only known specimen. Endemic.
4. *Typhlops porrectus* Stoliczka. This species occurs in India and Burma. It was recorded for the first time from Ceylon in 1897 by Méhely. Smith reports a specimen from Punduloya, Ceylon.
5. *Typhlops braminus* (Daudin), a widely distributed species, long known from Ceylon.

* The Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese Sub-Region; Reptilia and Amphibia, Vol. III, Serpentes, Dec. 1943, London pp. I-XII, 1-583, text figs. 1-166, 1 map.

In the Edward H. Taylor-Hobart M. Smith Collection there are 36 examples of these diminutive, "blind" snakes from Ceylon. Most of the specimens were obtained in the region 12 miles north of Trincomalee where the land is only about three to five meters above sea level. Two are from the mountainous region near Peradeniya. Of these two specimens, one belongs to the well-known *Typhlops braminus*, the other is an example of the rare *Typhlops mirus*.

Of the 34 specimens from the region north of Trincomalee, not one seems to belong to a described species; but they are separable into several distinct forms which are here described as new. All were obtained in sandy soils. Several were found within a few feet of high-water mark on the shore of a saltwater lagoon, in debris left by the waves. The soil was disturbed to a depth of only 3 to 4 inches while looking for them. Others were found by systematically moving accumulations of leaves on the forest floor, or debris from about the base of coconut trees.

Typhlops porrectus Stoliczka

Typhlops porrectus Stoliczka, Journ. Asiat. Soc. Bengal, Vol. XI, 1871, p. 426, pl. XXV, figs. 1-4 (Type locality, Bengal, India). Méhely, Termes. Fuzetek, Vol. XX, 1897, p. 62 (Kala-wewa, Ceylon). Smith, Fauna British India, Ceylon and Burma including the whole Indo-Chinese Sub-region, Reptilia and Amphibia, Vol. III, 1943, p. 46 (Pundulova, Ceylon).

This species is widespread in India but apparently it is uncommon in Ceylon. Two records, that of Méhely in 1897, and that of Smith in 1943 are the only specimens that have been reported.

The characteristics of this species, 18 scale rows, diameter of body in length 50-60 times, an incompletely divided nasal and the 400-440 transverse scale rows, clearly separate it from other known Ceylonese forms.

Typhlops mirus Jan

Typhlops mirus Jan, Iconographie Générale des Ophidiens, livr. 1, 1860, p. 9, pls. 5 & 6, fig. 7 (Type locality, Ceylon). Gunther, Reptiles of British India, 1864, p. 176, pl. 16, fig. H; Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, p. 126; Boulenger, The Fauna of British India including Ceylon and Burma, Reptilia and Batrachia, 1890, p. 240; and Catalogue of the Snakes in the British Museum (Natural History), Vol. 1, 1893, p. 52; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 7-9, fig. 1; Journ. Bombay Nat. Hist. Soc., XXIX, 1923, p. 348; Smith, The Fauna of British India including Ceylon and Burma, Reptilia and Amphibia, Vol. III, Serpentes, Dec. 1943, p. 55. (Ceylon. Known definitely from Peradeniya.)

A single specimen, EHT-HMS No. 30094, from Peradeniya, Ceylon, is in the collection. It may be well to record the characters of this specimen in some detail.

Head rounded in lateral profile, the nostrils ventrolateral, not visible from above; the width of the rostral equal to half (or slightly

mo.) the width of the head, and not enclosed by the nasals;† a suture completely divides the nasal, and reaches to the second labial; the area of the anterior (inferior) portion is equal to one-sixth the area of posterior (superior) portion; preocular a little smaller than ocular; no trace of eye discernible; subocular present‡ as large as ocular; dorsal head scales larger than body scales, but frontoparietal, frontal, interparietal, supraoculars and parietals smaller than ocular or preocular; first labial smaller than second; second larger than third, but much smaller than fourth; three posterior labials in contact with the subocular.

Mental distinctly larger than adjoining scales; three (or two) lower labials (second and third may be partially fused) wholly concealed when the mouth is closed. Tail lacking the terminal sharp-pointed spine, but having a low rounded elevation.

Brown above; the snout and lower parts yellowish with a sparse amount of pigment.

Scale rows about the body, 18; transverse scale rows around body, about 317;§ on tail 14. Total length, 131 mm.; tail length, 4 mm.; head width, 2.4 mm.; body width, 3.1 mm.; body width in total length, about 42 times.

There is some irregularity in the shape and size of the caudal scales. Smith (*loc. cit.*) gives the range of transverse scales as 330-360; and the maximum length, 140 mm.

Typhlops ceylonicus Smith

Typhlops mirus Wall (part), Oplidia Taprobana or the Snakes of Ceylon: Colombo, 1923, p. 7. (In one place, in a table the nasals are reported as meeting behind rostral. At the bottom of the page he states "sometimes in contact behind the rostral.")

Typhlops ceylonicus Smith, Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese Sub-Region, Reptilia and Amphibia Vol. III, Serpentes, Dec. 1943, pp. 55-56. (Type locality Peradeniya, Ceylon.)

Smith's description of the unique type follows:

"Snout rounded, strongly projecting; nostrils lateral; rostral nearly half the width of the head; nasal completely divided, the lower suture passing to the second labial, the posterior shield very large, in good contact with its fellow behind the rostral; ocular and preocular small the latter separated from the labials by a subocular, which is wedged in between them above, and is in contact with the

† Wall, *loc. cit.* notes that the nasals are sometimes in contact behind rostral. This is the condition in *T. ceylonicus*. The specimen showing this condition may be the type of that species.

‡ Boulenger, *loc. cit.* in the "Catalogue," page 14, (key) attributes two suboculars, erroneously, to this species.

§ Counts vary within limits of two or three scale rows on most specimens of *Typhlops*, depending upon which side or which particular row is counted.

2nd, 3rd and 4th labials below; no visible eye, the ocular shield in contact with the 4th labial only; tail blunt, without terminal spine; 18 scales round the body, the diameter of which is 35 times in the total length; about 330 transverse rows of scales. Brown above yellowish-white below. Total length: 140 mm.

"Known from a single specimen obtained at Peradeniya, Ceylon. Type in the Indian Museum."

Smith points out two distinctive characters by which this differs from *mirus*; the union of the nasals behind the rostral and the stouter proportions. The diameter is contained in total length 35 times (as compared with 40-50 times in *mirus*).

Wall has regarded this form as a variant of *Typhlops mirus* Jan. I have seen no specimens.

Typhlops leucomelas Boulenger

Typhlops leucomelas Boulenger, The Fauna of British India including Ceylon and Burma, Reptilia and Batrachia. London, 1890, pp. 237-238 (Type locality: Havelock Mountain, 40 mi. from Galle, Ceylon, 2,000 ft. elevation.); and Catalogue of the Snakes in the British Museum (Natural History) Vol. 1, 1893, pp. 18-19, pl. 1, fig. 4; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 13-15, fig. 4; and Spolia Zeylanica, Vol. XII, 1922, p. 253, and Journ. Bombay Nat. Hist. Soc., XXIX, 1923, p. 350; Smith, The Fauna of British India, Ceylon, and Burma including the whole of the Indo-Chinese Sub-Region Reptilia and Amphibia Vol. III, Serpentes, Dec. 1943, p. 50.

Boulenger's description follows:

"Snout rounded and moderately projecting; nostrils lateral. Rostral narrow, its upper portion about one third the width of the head, extending to between the eyes; nostril between two nasals, the anterior of which is in contact with the first and second labials and extends to the upper surface of the head; a preocular, nearly as large as the ocular, in contact with the second and third labials; eyes distinct; upper head-scales a little larger than the scales on the body; four upper labials. Diameter of body 32 times in the total length; tail slightly longer than broad, ending in a point; 22 scales round the body. Blackish brown above, pure white inferiorly.

"Total length 150 millim."

The figures four, a, b, c, Plate I, show the following additional characters: Supraoculars and parietals equal in size to, or smaller than, the frontonasal; suture of supraocular and ocular not crossing eye; second labial two-thirds as large as the third; third labial as large as fourth; three preanals present. No posterior parietal distinguishable; two postoculars; rostral narrowed almost to a point on the labial border.

M. Smith's statement concerning *leucomelas* (*loc. cit.*): "Differs from *jerdoni* as follows: Breadth of rostral above that of head;

diameter of body, etc." is not clear. It is either a *lapsus* or certain words have been accidentally dropped by the printer.

Typhlops lankaensis sp. nov.

Type: EHT-HMS No. 30062, collected 12 miles north of Trincomalee, Ceylon, Sept. 13, 1944, by Edward H. Taylor.

Paratypes: EHT-HMS Nos. 30060-30061; 30064-30071; 30073-30078; 30080-30085; 30088, 31258, all topotypes.

Diagnosis: Head oval, seen from above; suture, dividing nasal completely, reaches to preocular; 20 scale rows about body; rostral somewhat less than one-third greatest width of head; transverse scale rows about body, 229-261; generally brown to gray-brown above with very dim longitudinal dorsal lines, the median most distinct; under side of head very largely cream color.

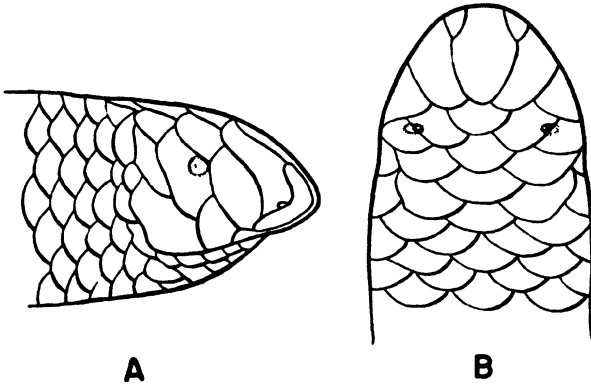


FIG. 1. *Typhlops lankaensis* sp. nov. A, lateral view of head; B, dorsal view of head. Much enlarged. From the type EHT-HMS No. 30062.

Description of type: Head oval in outline when seen from above; rostral between one-fourth and one-third the greatest width of head, failing to reach back to level of eye by a distance less than half the width of the prefrontal; nasal completely divided, the suture emerging at preocular, the upper (posterior) part distinctly longer and about a fourth larger than lower (anterior) part; median head scales wider than long, the prefrontal smaller than the frontal; latter scale smaller than the interparietal; the scale following interparietal, is wider but shorter than that scale; supraocular larger than any of the median scales, and likewise larger than parietals.

Four labials, the first two-thirds of second; fourth two and one-half times the size of third; ocular shorter but wider than preocular;

a single postocular; three lower labials, or the second may be partially fused with third which is large and concealed when mouth is closed.

Body scales in 20 longitudinal rows; individual scales usually wider than long, the median ventral series slightly wider and slightly larger than adjoining rows throughout the greater part of length. Transverse scale rows about 256 around body, 12 on tail; five somewhat enlarged, transparent anal scales, the outer, lateral, larger than the medial scales.

Color: Above light brown, darker dorsally, lighter laterally and ventrally; ventral and lateral parts of head immaculate cream; subsquamous glands on head distinctly outlined forming an intricate pattern; scales on 9 dorsal rows slightly lighter on the edges, so that 7 (or 9) dim, scarcely discernible lines are formed on dorsal longi-

Table of scale counts and measurements of *Typhlops lankaensis*

Number	Transverse scale rows body	Transverse scale rows on tail	Longitudinal scale rows	Total length	Tail length	Body width
30060.....	231	14	20	101	4.45	3.5
30061.....	244	11	20	82	3.0	3.0
30062.....	256	12	20	117	3.0	3.8
30064.....	254	13	20	103	3.5	3.5
30065.....	243	13	20	116	4.7	3.3
30066.....	253	13	20	112	3.3	3.8
30067.....	258	15	20	116	3.9	3.85
30068.....	261	13	20	119	3.0	3.5
30069.....	240	14	20	96	4.3	3.0
30070.....	240	14	20	91	3.3	3.15
30071.....	254	13	20	101	4.3	3.7
30073.....	243	14	20	96	3.8	3.2
30074.....	245	13	20	103	4.5	3.0
30075.....	258	12	20	130	3.8	3.9
30076.....	229	15	20	97	4.35	3.4
30077.....	259	14	20	116	4.5	3.8
30078.....	257	14	20	114	4.0	3.8
30080.....	255	13	20	78	3.5	2.6
30081.....	246	13	20	100	3.2	2.7
30082.....	253	14	20	104	4.0	3.3
30083.....	240	14	20	102	4.1	3.3
30084.....	249	11	20	115	3.2	3.5
30085.....	237	13	20	92	3.3	3.0
30088.....	240	13	20	104	4.0	3.3
31255.....	245	13	20	67	2.4	2.3

tudinal scale rows. An unpigmented area about vent, cream; the terminal tail spine grayish.

Measurements: Total length, 117 mm.; tail length, 3 mm.; width of body, 3.8 mm.; width in total length, about 30 times.

Remarks: The very low number of the transverse rows of scales seems to distinguish this species from other Ceylonese species as well as from the continental forms.

The ancient name for the island of Ceylon is Lanka. It is from this that the specific name has been derived.

Typhlops violaceus sp. nov.

Type: EHT-HMS No. 30091; collected 12 miles north of Trincomalee, Ceylon, Oct. 5, 1944, by Edward H. Taylor.

Diagnosis: A small *Typhlops* with eyes dim, but discernible; the nasal completely divided; the nostril lateral but not visible above, the suture dividing nasal touching the preocular far from the labial; 20 longitudinal scale rows; none or only a very small terminal spine; 245 transverse scale rows on body; body width in total length about 31 times. Color, dull violet to lavender, almost the same above and below.

Description of type: Head somewhat truncate-oval seen from above, the snout rather bluntly wedge-shaped in lateral profile, the top of head flattened; rostral tongue-shaped, failing to reach back to eye level by a distance equal to about two-thirds width of the prefrontal; nasal completely divided, the suture reaching the preocular at some distance from the labial, the upper part being about a fifth greater in area than the lower, and its greatest width a little more than that of the preocular; the lateral sutures formed by the rostral with the anterior part of the nasal show slight depressions noticeable when seen from below; preocular larger than the ocular, and much longer; prefrontal scarcely wider than long; frontal and first interparietal about equal in size, both larger than prefrontal but distinctly smaller than the second interparietal; supraocular largest of these scales and more irregularly shaped, its lower edge crossing the eye, the suture with the preocular much in front of eye; parietals, both anterior and posterior, about equal to last interparietal; body scales following are smaller (less than half) than head scales; four upper labials, first two-thirds of second; second about a half area of third; third a little more than half of fourth. Preanal scales, five, the outermost much enlarged; ap-

parently no terminal spine or at most only a diminutive one (terminal scale shed). Terminal part of tail not bent down strongly.

Scales on body rather strongly rounded behind, in 20 longitudinal rows; transverse rows, 245 about body, 13 on tail.

Color: Above and below dull violet to lavender, only slightly lighter below; scales about mouth light, with some very slight pigmentation.

Measurements: Total length, 111 mm.; tail, 2.5 mm.; diameter of body, 3.6 mm.; body width in total length about 31 times.

Typhlops braminus Daudin

Eryx braminus Daudin, Histoire Naturelle générale et particulière des Reptiles, Vol. VII, year XI (= 1803), pp. 279-280. Based on Russel's *Rondou-Taloulou-pam* in, An account of Indian Serpents collected on the Coast of Coromandel, Vol. I, p. 48, pl. XLIII (Type locality Visagapatam, India).

Typhlops braminus Boulenger, Catalogue of the Snakes in the British Museum (Natural History), Vol. I, 1893, p. 16; Wall, Ophidia Taprobanica or the Snakes of Ceylon; Colombo, 1921, pp. 7, 9-13 (figures apparently represent another species); Smith, The Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese Sub-Region; Reptiles and Amphibia, Vol. III, Serpentes, Dec. 1943, pp. 46-48, fig. 14, head.

This very widespread species, *Typhlops braminus* has been reported by Wall as being "very abundant" in Ceylon. Boulenger, *loc. cit.* lists three Ceylon specimens. In the EHT-HMS collection is a specimen from Peradeniya, Kandy District (No. 30093). Although it is somewhat faded it agrees with *T. braminus* in the scale characteristics and counts.

I strongly suspect that Wall (*loc. cit.*) has confused more than one species with *T. braminus*. The figures he gives, if correctly drawn, cannot belong to this species, but represent an undescribed form. The rostral widens anteriorly instead of narrowing; the character of the dorsal head scales is different; three instead of five preanal scales are shown. It may be that the species here described as *T. lankaensis* was likewise confused with *T. braminus* by Wall since superficially they resemble each other, and it is likely that specimens of that species are present in the collections that Wall examined.

The specimen, No. 30093, has 317 transverse scale rows about the body, and 15 about the tail. The total length is 123 mm., the diameter of the body (3.1 mm.) about 40 times in length. There are 20 longitudinal scale rows on the body. The rostral is a little less than a third the width of the head, widest near the posterior end, narrowing anteriorly; the suture of the completely divided nasal reaches the preocular. Under part of the snout, the anal region and the terminal spine cream or whitish. In life the dorsal coloration

is blackish or blackish brown above and somewhat lighter on the ventral surfaces. There is no subocular present.

The range of the transverse scale rows (ventrals) for *Typhlops braminus* is given by Smith, *loc. cit.* as 290-320; the diameter of the body, contained in total length, varying between 30-45 times; greatest length 170. Smith points out that the internasal suture which usually touches the preocular may sometimes touch the second labial, noting that certain forms in India previously described as new, should be regarded merely as synonyms. This may be true in certain cases, but in others not only the condition of the nasal suture, but other characters as well might warrant a separation. The matter should be reexamined when more material is at hand.

Typhlops malcolmi sp. nov.

Type: EHT-HMS Nos. 30072; collected 12 miles north of Trincomalee, Eastern Province, Ceylon, Nov. 1944, by Edward H. Taylor.

Paratype: No. 30090, same data, Oct. 5, 1944.

Diagnosis: A small bicolored snake having 20 longitudinal scale rows. 261-273 transverse scale rows around body; fourth labial twice as large as third, notched behind; a single postocular present; brown above and cream below with a brownish pigmented band crossing throat. Glands on head form a distinct, lighter pattern.

Description of the type: Rostral rather elongate, reaching back to level of the middle of the eyes, beginning to narrow at the most posterior point of lower nasal; nasal completely divided by a suture which terminates at the second labial; the lower, anterior portion somewhat more than one-half the area of the upper, posterior part; posterior nasals not in contact behind rostral; prefrontal slightly smaller than ocular, followed by a frontal slightly wider but of the same shape; the suture of the ocular with supraocular crosses the eye; suture between the supraocular and the preocular barely touches the anterior edge of the eye; two parietals and two interparietals, the anterior parietals largest; preocular as wide as ocular but higher.

Four labials, first about one-half area of second; second two-thirds the area of the third; third a little less than half the area of the fourth; latter slightly notched on its posterior border; a single postocular present; lower lip bordered by a very tiny mental and two labials, a small anterior and a greatly elongated and narrow posterior reaching to angles of the mouth; tail ending in a blunt spine; five preanal scales, the outer one on each side, largest.

The transverse scale rows on the body 262, those on tail 11. Longitudinal scale rows 20; length 107 mm.; width 3.45 mm.; width in total length about 31 times. Tail length 4.5 mm.; head width 2.8 mm.

Color in life: Above brown on the eight dorsal rows, the color heaviest on the median dorsal rows, and lighter on the sides; two other lateral rows with some pigment; lower lateral and ventral rows dull cream to flesh color lacking pigment save for a light brownish band several scales wide crossing the throat.

The paratype, No. 30090, has 273 transverse scale rows on body and 9 on the tail; there are 20 longitudinal rows around the body. The total length is 81 mm., the tail 2.2 mm., head width 2 mm., width of body 2.6 mm., width into body length about 31 times.

The coloration conforms to that of the type save that it is definitely lighter. The band of pigment crosses the throat as in the type. The terminal spine is without pigment.

The relationship appears to be with *Typhlops leucomelas*, but it may be distinguished by the smaller number of longitudinal scale rows, lighter color, the band of color about throat and the different labials.

This is a lowland species living in sand on the forest floor.

The species is named for Malcolm Smith, now of the British Museum of Natural History, who has published widely on the herpetology of Southern Asia.

Typhlops tenebrarum sp. nov.

Type: EHT-HMS No. 30063; collected 12 miles north of Trincomalee, Ceylon, Oct. 5, 1944, E. H. Taylor, collector.

Paratypes: EHT-HMS Nos. 30079, 30086, 30087, all topotypes.

Diagnosis: A very slender *Typhlops* with the nasal suture com-

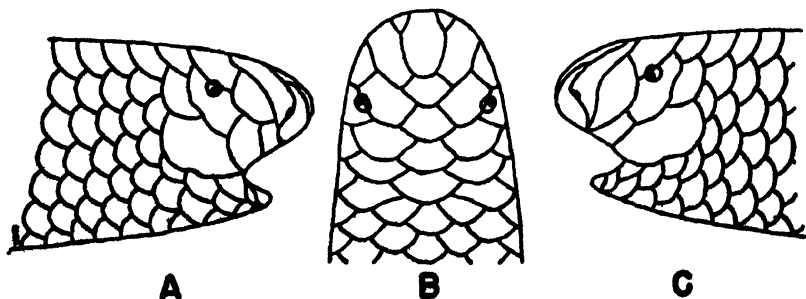


FIG. 2. *Typhlops tenebrarum* sp. nov. Views of head. A, lateral view; B, dorsal view; C, lateral view of left side, showing presumed abnormal condition. All figures much enlarged. From the type EHT-HMS No. 30063.

pletely dividing the nasal and reaching the second labial; width contained in length from about 43 to 56 times; number of transverse scale rows about body from about 298 to 326 rows; 12 to 14 on tail; 20 longitudinal scale rows about body; light brown above, lighter below and on sides; scales bordering the mouth cream color.

Description of the type: Seen from above, the head is rounded anteriorly; greatest width of rostral one-third (or slightly less than) greatest width of head; rostral widest where scale touches most posterior (upper) part of the anterior (lower) nasal, then narrows, the sides being parallel almost to the border of mouth; the suture which completely divides the nasals emerges at the second labial, the lower part much more than half the area of the upper part; prefrontal about as wide as long, separating upper nasals, about the same size and shape as the frontal, and the anterior interparietal; posterior interparietal larger than other scales of the median row; supraocular larger than the prefrontal or frontal, its lower edge crossing eye near middle; preocular a little larger than ocular; a single postocular; eye rather indistinct, seen as a rather blackish spot (somewhat more distinct in younger specimens); four upper labials, first about a third the area of second; latter much less than half of third; fourth labial nearly double area of third (on left side the second labial is anomalously missing, partially fused to preocular, partly to third labial, the suture reaching the reconstructed third labial); three lower labials but the second and third apparently almost completely fused, concealed when mouth is closed.

Scales in 20 longitudinal rows; transverse scale rows about 320 on body, 12 on tail; preanals five, largely transparent, the outer scales largest.

Measurements: Total length, 111 mm.; tail, 2 mm.; width of body, 2.5 mm.; body width in total length, about 44 times.

Table of variation for *Typhlops tenebrarum*

Number	Transverse rows, body	Transverse rows, tail	Longitudinal scale rows	Total length	Tail	Diameter of body
30063.....	320	12	20	111	2.0	2.5
30079.....	300	13	20	112	3.0	2.0
30086.....	298	14	20	70	1.9	1.55
30087.....	326	13	20	65	1.8	1.5

Color: Above brownish to dull chestnut, the pigment more dense on the nine dorsal rows, lighter on lower laterals and ventrals; scales about mouth cream color.

Variation: The three topotypic paratypes show certain variations. The following table indicates variation in scale counts and measurements:

In all the specimens the suture of the nasals reaches to the second labial; a small terminal spine is present, sometimes blunt.

No. 30079 shows a singular variation in having the ocular and the supraocular fused for the greater part of the common suture, and the eyes are distinct; the tail curves sharply down at tip.

No. 30086 has the second interparietal abnormally broken.

Typhlops veddae sp. nov.

Type: EHT-HMS No. 30089; collected 12 mi. north of Trincomalee, Ceylon, Sept. 29, 1944, by E. H. Taylor.

Diagnosis: A very slender *Typhlops* having 20 scale rows, no subocular, the nasal suture to the second labial, the rostral short failing to reach back to eye level by a considerable distance; head somewhat narrowed, and truncate anteriorly; the transverse scale rows about body 295; 14 caudal rows; body width in length about 60 times.

Description of type: Width of the rostral about one-third the width of head at the level of eyes, failing to reach anterior level of eyes by three-fourths the width of prefrontal; nostril between two completely divided nasals, the upper nearly double area of the lower but not meeting its fellow behind rostral, the suture reaching

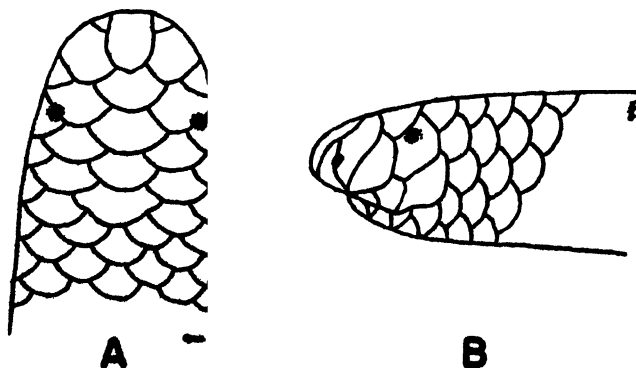


FIG. 3. *Typhlops veddae* sp. nov. A, dorsal view of head; B, lateral view of head. From the type EHT-HMS No. 30089. Much enlarged.

to the second labial; median head scales, the prefrontal, frontal, and interparietals, all about the same size and all broader than long; supraoculars, anterior and posterior parietals of nearly same shape but a trifle smaller than head scales of the median row; the fourth scale in this series not or only slightly enlarged; four upper labials, the fourth about one and one-third times larger than third; suture from the nostril reaching second labial which is about half as large as third; two lower labials on each side, concealed when mouth is closed; preocular about as large as the ocular, their common suture distinctly in front of eye; suture between the ocular and supraocular crosses upper edge of eye; scales of head all showing minute spinules. Eye a dim black spot, easily discernible.

Head seen from above tapers slightly to the somewhat truncate snout; in lateral profile the snout slopes downward from posterior part of nostril but the tip of the snout is rounded; subsquamous glands of head scarcely discernible, save along the edges of rostral.

Scales about body in 20 longitudinal rows and in about 295 transverse rows; 13-14 rows around tail; preanal scales five, somewhat enlarged; tail terminating in a small, rather indistinct spinelike scale.

Color: Lavender-gray throughout, with some trace of darker markings on scales when studied under a lens (especially on ventral scales); no trace of lighter areas on head, anal region, or tail. Total length, 90.5 mm.; body width (average), 1.51 mm.; head, 1.5 mm.; tail, 2.75 mm.

Remarks: The species, judging by its very slender habitus, and the large number of transverse scale rows is related to *Typhlops braminus*, and to *Typhlops tenebrarum*, described herein. It differs from the former in coloration, characteristic pattern of glands, in having the nasal suture touch the labial rather than the preocular. The shape of the head and particularly the shape of the snout, is quite different; the eye is dim, and the diameter of the body is contained into its length 60 instead of "30-45" times and the tail is proportionally longer.

The type was taken from decaying wood debris, in second growth forest.

The Veddas are an ancient people of Ceylon, now represented by small groups occupying a few villages in the wilder parts of the island.

DISCUSSION

Of the five new species described here, *Typhlops lankaensis* has probably been collected before, but its superficial resemblance to *T. braminus* may have caused it to be confused with that species. In the past many herpetologists have failed to make counts of transverse scale rows in these snakes and as a consequence they have overlooked striking differences in forms they have regarded as conspecific.

Fortunately there is a good series of *T. lankaensis* from a single locality, and the variation that obtains cannot be attributed to geographical variation. It is a common species but considerable effort is necessary to find it.

In passing, it may be said that in this species and perhaps many other species of *Typhlops* there are two transverse scale rows for each vertebra rather than a single one, such as is true for the greater number of snakes. However in some forms, *T. beddomei* Boulenger for example, with an extraordinarily low count of only 190-200 transverse rows perhaps only a single scale now corresponds to a single vertebra; and in a form such as *T. thurstoni* Boettger with the remarkable count of 550-600 transverse rows, perhaps more than two rows correspond to a vertebra. No specimens of these forms are available to me for examination.

Typhlops malcolmi with 20 longitudinal rows is clearly distinguished from *T. leucomelas* with 22 longitudinal rows. It may also be distinguished by color differences—black dorsally in *T. leucomelas* and brown in *T. malcolmi*. There are also differences in the relative sizes of the labials. *T. malcolmi* has a band of pigment across the throat, lacking in *leucomelas*. It would appear that *T. leucomelas* is a mountain form, while known specimens of *T. malcolmi* are from the sandy northern lowlands.

The "key" differences between *Typhlops violaceus* and *T. lankaensis* may seem unimportant. However the shape of the head, and the resultant changes in scale proportions make for distinct differences that are rather hard to put into words. In *violaceus* the snout extends farther in front of the mouth, and the point at which the nasal suture reaches the preocular is about double the distance from the edge of the mouth as the same point in *T. lankaensis*. The part of the rostral visible above in *T. violaceus*, especially the anterior narrowed part, is very much longer than the same part in *T. lankaensis*. Color alone will separate the species, and numerous

other differences become obvious when individual scales are compared.

The two species *Typhlops veddae* and *T. tenebrarum* resemble *T. braminus* in the counts of the transverse scale rows, and by this same character are separable from *T. lankaensis* and *violaceus*.

They both differ from *T. braminus* in having the terminus of the nasal suture at the first labial rather than at the preocular, thus bringing the point of contact close to the mouth with the resultant differences in scale proportions and relationships. The body in these two species is distinctly slenderer than the body in *T. braminus*. The distinctions between *T. veddae* and *T. tenebrarum* are pointed out in the key.

One must not overlook the possibility that certain Indian forms now in synonymy may prove to be distinct species when sufficient specimens are available to prove them part of distinctive populations and not anomalies.

It is more or less consistent behavior of genera of burrowing species of snakes to diversify in greater extent than more terrestrial or arboreal forms thus less handicapped in movement. Burrowing habits make for lack of mobility and serve in a measure as an isolating factor.

KEY TO THE SPECIES OF *TYPHLOPS* IN CEYLON

1. Scales in 18 longitudinal rows about body; nasal variable..... 2
2. Scales in 20 or 22 rows about body; nasal divided..... 4
3. Nasal incompletely divided, the suture to 2d labial; no subocular; small terminal tail spine; eye distinct; 330-360 transverse scale rows; length 285 mm.: Blackish brown above, paler below..... *T. porrectus*
4. Nasal completely divided, the suture to 2d labial; a subocular present; no terminal tail spine; eye usually not visible..... 3
5. Upper (posterior) nasals separated behind rostral; 330-360 transverse scale rows on body, brown above paler below, length 140 mm.; head partly or almost entirely cream *T. mirus*
6. Upper (posterior) nasals forming a median suture behind the rostral; 330 transverse scale rows on body; brown above, yellowish white below; length 140 mm., *T. ceylonicus*
7. Scales in 20 longitudinal rows about body..... 5
8. Scales in 22 longitudinal rows about body; eye distinct; nasal suture to 2d labial; (260-280 scale rows, said to agree with *jerdoni*). Black above, whitish below, the colors meeting in a clear line of demarcation; length 130 mm., *T. leucomelas*
9. Nasal suture goes to the preocular..... 7
10. Nasal suture goes to second labial..... 10
11. Transverse rows of scales on body more than 280..... 9
12. Transverse scale rows on body less than 275..... 8
13. Transverse scale rows, 229-261 on body; subaquamous glands on head forming distinct pattern; eye distinct; underside of head largely cream; part of rostral visible above shorter; length 130 mm..... *T. lankaensis*
14. Transverse scale rows on body, 245; subaquamous glands on head not visible; eye rather indistinct; part of rostral visible above much elongate; snout somewhat truncate at tip; dull violet to lavender; length, 111 mm..... *T. violaceus*

9. Transverse scale rows on body, 290-290. Pattern of subaquamous glands distinct; eye normally distinct; blackish brown above, paler below; length 170 mm. *T. brownianus*
10. Body more attenuated; transverse scale rows on body above 290..... 11
 Body less attenuated; transverse scale rows 261-273, body brownish above, the pigment becoming less on sides; venter cream save for a pigmented band on throat; eye distinct; width into body length, about 31 times; length, 107 mm.,
T. malcolmi
11. Transverse scale rows, 298-326; width of the body into length about 43 to 55 times; light brown above, lighter below. Scales bordering mouth cream; snout rounded anteriorly; upper nasal one-third larger than lower. 3d labial about half area of fourth; length 113 mm..... *fenestratum*
 Transverse scale rows 295; body width into total length about 60 times; head truncate, subaquamous glands not or scarcely discernible; length 90 mm.... *veddae*

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NOVEMBER 1, 1947

[No. 14]

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By EDWARD H. TAYLOR

ABSTRACT: The four forms of *Sphaerodactylus* described from Mexico are discussed. *Sphaerodactylus glaucus* Cope and *Sphaerodactylus torquatus* Strauch are regarded as valid forms belonging in the Mexican fauna. *Sphaerodactylus anthracinus* Cope, is valid but its Mexican origin may be questioned. The status of *Sphaerodactylus inornatus* must be regarded as doubtful both as to its place of origin and its validity as a species.

THE diminutive lizards of the genus *Sphaerodactylus* have been known definitely from Mexico since the publication of the description of *Sphaerodactylus glaucus* Cope, in 1865. Nevertheless they have remained rarities in collections, at least until recently. Barbour who reviewed the genus in 1921, said of *S. glaucus*: "It appears in so very few of the many collections made in Mexico and Central America that it must be very rare."

In 1936 Doctor Hobart M. Smith obtained in Campeche a series of 82 specimens belonging to the species *Sphaerodactylus glaucus*. Doctor Norman Hartweg and Doctor James Oliver succeeded in obtaining a series of 56 specimens of *S. glaucus* in Tehuantepec. Of these they state "vicinity of Tehuantepec; Quiengola Mountain UMMZ. Nos. 82292-82303 (56). All except three of the specimens seem to be typical *glaucus*; the 3 each have a dark collar on the neck." (Hartweg and Oliver 1940.)

Four species have been described from type localities in Mexico. These are *Sphaerodactylus anthracinus* Cope, "Mexico" [Jalapa?], December, 1861; *Sphaerodactylus glaucus* Cope, near Mérida, Yucatán, 1865; *Sphaerodactylus torquatus* Strauch, "Mazatlán," Mexico, May, 1886; and *Sphaerodactylus inornatus* Peters, "Mexico," 1873. Barbour who reviewed the genus in 1921 regarded *anthracinus* as a valid species but one not occurring in Mexico; *torquatus*

9. Transverse scale rows on body, 290-320. Pattern of subsquamous glands distinct; eye normally distinct; blackish brown above, paler below; length 170 mm. *T. brunnus*
10. Body more attenuated; transverse scale rows on body above 290..... 11
 Body less attenuated; transverse scale rows 261-272, body brownish above, the pigment becoming less on sides; venter cream save for a pigmented band on throat; eye distinct; width into body length, about 21 times; length, 107 mm.,
T. malcolmi
11. Transverse scale rows, 298-326; width of the body into length about 43 to 56 times; light brown above, lighter below. Scales bordering mouth cream; snout rounded anteriorly; upper nasal one-third larger than lower. 3d labial about half area of fourth; length 112 mm..... *fenebrum*
 Transverse scale rows 295; body width into total length about 60 times; head truncate, subsquamous glands not or scarcely discernible; length 90 mm.... *veddes*

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THE diminutive lizards of the genus *Sphaerodactylus* have been known definitely from Mexico since the publication of the description of *Sphaerodactylus glaucus* Cope, in 1865. Nevertheless they have remained rarities in collections, at least until recently. Barbour who reviewed the genus in 1921, said of *S. glaucus*: "It appears in so very few of the many collections made in Mexico and Central America that it must be very rare."

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as a synonym of *glaucus*; and *inornatus* as a synonym of *lineolatus*, but from some locality, not Mexican. The status of these four forms is discussed in the following pages.

Sphaerodactylus anthracinus Cope

Sphaerodactylus anthracinus Cope, Proc. Acad. Nat. Sci. Philadelphia, Dec. 1861, p. 800 (Type description; type locality, "Mexico," [Jalapa?]-Mus. Philadelphia); von Müller, Reisen in Vereinigten Staaten, Canada und Mexico, vol. 3, 3rd pt., 1865, p. 599 (listed from Mexico; no specimen, Cope cited); Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 27 (listed from Mexico); Peters, Monatsb. Königl. Akad. Wiss. Berlin, 1869, p. 374 (listed from Puebla); Boulenger, Catalogue of the Lizards in the British Museum (Natural History), vol. 1, 1885, p. 225 (Mexico; San Domingo, one specimen); Günther, Biologia Centrali-Americana, 1865, p. 88 (no specimens); Barbour, Mem. Mus. Comp. Zool. Harvard College, Vol. 47, No. 3, Dec. 1921, pp. 258-259 (Andros Island).

Cope believed that the types of *Sphaerodactylus anthracinus* came from Mexico, and listed Mexico as the type locality for the species. Barbour, who had available two specimens from Middle Bight, Andros Island, Bahamas, the types of *Sphaerodactylus asper* Garman, found the two species to be synonymous, and concluded that the type of *anthracinus* must have originated on Andros Island. He states (Barbour 1921 p. 258): "The original description stated that the type came from Mexico. This has been copied by Boulenger and others. It seemed at once highly improbable that a sphaerodactyl of this style should occur upon the mainland. The type-specimen was, therefore, carefully examined and found to be absolutely identical with examples from Andros Island in the Bahamas. It has not been rediscovered in Mexico, and the locality is certainly erroneous."

Contrary to the statement that the form had not been rediscovered in Mexico, is the published statement of Peters (1869) who records a specimen from Puebla (presumably from near Izucar de Matamoros in the southern part of the state). This collection made by Hr. Berkenbusch, was sent from Mexico and there seems to be little chance of a mix-up of data. Whether it is misidentified is another question; but the size, the unusual iron gray color and the character of the large scales seem to preclude the chance of its being confused with the small smooth scaled *torquatus* or *glaucus*. This reference seems to have been overlooked by Barbour. Boulenger lists a British Museum specimen from San Domingo, a reference either overlooked or not mentioned by Barbour.

Perhaps one would be unwise to state definitely that the species occurs in Mexico on the basis of the two published records. However there is certainly as strong a possibility that it does occur as that it does not. Careful search made in the cities of Jalapa, Vera-

cruz, and Matamoros, Puebla, as well as in their surroundings may bring about its rediscovery. The fact that the species has not been taken in recent collections is certainly no proof that it does not occur.

The following type description is brief but the characters given are diagnostic.

"*S. anthracinus* Cope.

Size large, (head and body 1 inch, 9 lines); muzzle elongate acute; labials four above, two large and three small below; supranasal plates small, superior; frontal scales keeled; the dorsal strongly keeled, rounded, in ten rows on each side, extending for a considerable distance on the tail. Gular scales smooth. Color black, the large dorsal scales tinged with blue.

Hab. Mexico. Mus. Philadelphia."

Sphaerodactylus inornatus Peters

Sphaerodactylus inornatus Peters, Monatsb. Königl. Akad. Wiss. Berlin, 1872, p. 728 (type description; type locality Mexico, "Zwei exemplare aus Mexico; aus der Uhde'schen Sammlung; No. 4589. M. B.")

This species was questionably referred to the synonymy of *Sphaerodactylus glaucus* by Boulenger (1885) and it also appears in the synonymy of the species in Günther (1885). Apparently no change in this status was suggested until Barbour (1921) placed the form in the synonymy of *Sphaerodactylus lineolatus* Lichtenstein. He writes as follows of *lineolatus*: "This species seems to range widely through Lower Central America while *glaucus* is more northern in its range. Both species are known from Guatemala. Peters' type of *inornatus*, apparently a synonym of this species, is said to have come from Mexico far from the known range of *lineolatus*. It is more probable that the locality is incorrect than that Peters so noted for his precise and careful observing would have missed the peculiar dorsal squamation of *glaucus*."

The description of *S. inornatus* as given by Peters, follows:

"Sehr nahe verwandt mit *Sph. punctatissimus* D. B., aber die Schnauze ist kürzer, ohne Canthi rostrales, das Rostralschild ist ebenfalls kürzer und merklich höher, die Supranasalia sind kleiner und die ganze Beschuppung ist etwas feiner. Die sehr kleinen Rückenschuppen sind flach und glatt, ebenso wie die merklich grösserer Bauchschuppen. Labialia jederseits vier oben und unten.

Graubraun mit einzelnen kleiner schwarzen Punkten namentlich an den Körperseiten. Mit der Lupe betrachtet sind die einzelnen Rückenschuppen mit zwei bis drei kleinen dunkeln Pünktchen versehen.

Zwei Exemplare aus Mexico; aus der Uhde'schen Sammlung. (No. 4589 M. B.)"

Whether Boulenger or Barbour is correct regarding the synonymy cannot be stated at the present time. It is significant that Peters describes a species with markings unlike the Mexican *glaucus* and states concerning the squamation "Rückenschuppen sind flach und glatt." This is very different from the described squamation of *lineolatus* of which Boulenger says: "slightly keeled;" and Barbour: "extremely small juxtaposed granules, the centre of each swollen into what might be considered a keel." Until more material of this presumed species is discovered in Mexico, *inornatus* (or *lineolatus*) must have only a doubtful right to a place in the Mexican faunal lists.

Sphaerodactylus torquatus Strauch

Sphaerodactylus torquatus Strauch, Mem. Acad. Imp. Sci. St. Petersburg 1887, 7th ser. vol. 35, No. 2, May 1886, pp. 35-36 (type description; type locality, Mazatlán; No. 3268, Mus. Petrograd. 3 specimens. Hr. Salmin 1871 coll.); Günther, Biologia Centrali-Americana 1858, p. 82 (no specimens); Taylor, Univ. Kansas Sci. Bull., vol. 24, No. 20, 1936 (1937) p. 598, no specimens; listed for Sinaloa.

Sphaerodactylus glaucus (part.) Barbour, Mem. Mus. Comp. Zool. Harvard Coll. vol. 47, No. 3, 1921, pp. 240-241 (*torquatus* placed in synonymy).

The discovery of 25 specimens of *Sphaerodactylus* in Tehuantepec having characteristics of the species described by Strauch as *torquatus*, suggests the wisdom of removing this species from the synonymy of *S. glaucus* where it was placed by Barbour.

The illustrations of the color pattern of nearly equal-sized specimens of *torquatus* and *glaucus* on the somewhat conventionalized body outlines show the characteristic differences in the markings of the young of the two species. Of the numerous young of *glaucus* in the EHT-HMS collection, all specimens fit the pattern as depicted for that form. See fig. 2.

The type description of this species follows:

"Sphaerodactylus torquatus n. sp.

3268. Mazatlan. Hr. Salmin 1871, (3 Ex.).

Zunächst mit *Sphaerodactylus glaucus* Cope verwandt, mit dem er die kleinen, nicht gekielten Rumpfschuppen und das mässige grosse Rostralschild gemein hat, von dem er sich aber durch den viel gestreckteren Kopf, die gestrecktere, mehr zugespitzte Schnauze und die verschiedene Färbung und namentlich Zeichnung unterscheidet.

Die Schnauze unbedeutend länger, als der Zwischenraum zwischen Ohröffnung und Orbita. Die Ohröffnung klein und ausgesprochen horizontal gestellt. Das Rostrale von mässiger Grösse,

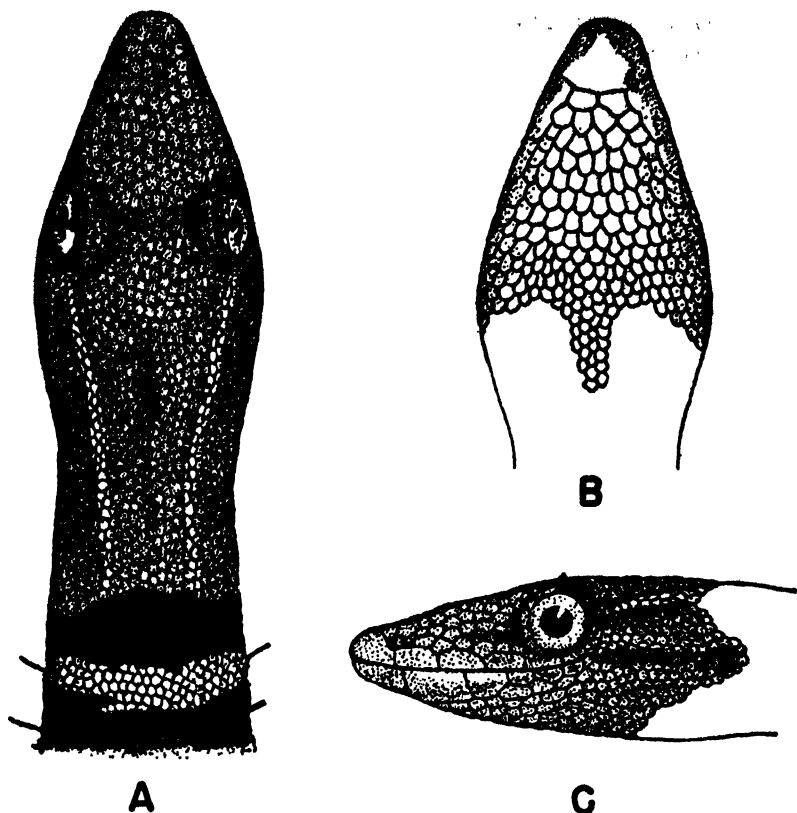


FIG. 1. *Sphaerodactylus torquatus* Strauch. A, dorsal view of head and neck; B, ventral view of head; C, lateral view of head (all greatly enlarged and slightly diagrammatic).

genau so beschaffen, wie Boulenger es auf Tafel XVIII, Fig. 3 von *Sphaerodactylus glaucus* Cope abgebildet hat. Jederseits 6 Supralabialia, die letzten sehr klein. Das Mentale gross, bedeckt die Spitze des Unterkiefers und besitzt einen leicht bogenförmigen Hinterrand; zu jeder Seite desselben stehen 6 Infralabialia, von denen die 3 vorderen sehr gross, die 3 hinteren dagegen sehr klein sind. Zwei grosse neben einander liegende Submentalia und hinter denselben 3 etwas kleinere in einer Querreihe; hinter diesen letzteren noch 2 oder 3 Querreihen von Schildchen, die successive an Grösse ab-, an Convexität aber zunehmen und so allmählich in die Kornschuppen der Kehle übergehen. Das Augenlid hat in der Mitte seines Oberrandes einen kleinen, nach hinten gerichteten Dorn. Die Oberseite aller Theile mit kleinen flachen Schuppen.

bedeckt, die auf dem Hinterkopfe besonders klein, kornförmig sind. Die Kehlschuppen sind, wie schon bemerkt, klein und convex, die Bauchschuppen dagegen plan, etwa doppelt so gross, wie die Rückenschuppen, und dachziegelförmig gelagert.

Die Oberseite zeigt auf hellen braunlichgelben Grunde braune Vermiculationen, die auf dem Kopfe in der Längsachse des Thiers verlaufen, während sie auf dem Rumpfe mehr der Quere nach gerichtet sind. Die Oberseite des Halses ist mit einem weissen, breit schwarz gerandeten Halsbande versehen, d. h. es finden sich daselbst drei gleichbreite Querbinden, eine vordere schwarze, die vor die Schulter liegt, eine mittlere weisse, welche die Schulter berührt, und eine hintere schwarze, welche hinter der Schulter liegt und in die Achselhöhle herabsteigt. Der Schwanz ist bei den beiden grösseren Exemplaren reproducirt und erscheint fast einfarbig bräunlich gelb, da die braunen Vermiculationen daselbst nur andeutungsweise vorhanden und sehr vereinzelt sind. Bei dem kleinen Stück dagegen, dessen Schwanz viel länger und sehr dünn ausgezogen, also augenscheinlich nicht reproducirt ist, zeigt er in seinem Enddrittel ähnliche Zeichnungen, wie sie nach Boulenger bei *Sphaerodactylus glaucus* vorkommen. Die äusserste Spitze ist nämlich weiss, vor derselben findet sich ein breiter schwarzbrauner Ringel; vor diesem Ringel sieht man auf der Oberseite in gleichen Abständen noch mehrere weisse Flecken, die mehr oder weniger deutlich braun gesäumt sind und nach der Schwanzbasis zu immer undeutlicher werden. Die Unterseite aller Theile ist sehr hell bräunlichgelb.

Maasse. Totallänge 49 mm.; Länge des Kopfes—8 mm.; des Rumpfes—21 mm.; des Schwanzes—20 mm. Bei dem kleinen Exemplar, dessen Schwanz, wie schon bemerkt, nicht reproducirt ist, beträgt die Länge dieses letzteren etwas mehr, als diejenige von Kopf und Rumpf zusammengenommen."

Whether "Mazatlan" the type locality of *Sphaerodactylus torquatus* is the port of that name on the west coast of Mexico is not certain. However it has generally been presumed that this seaport was meant. I searched for the species in 1934 while collecting in the vicinity of Mazatlán, Sinaloa, but found neither this species nor two other gekkoes that are mentioned by Strauch (1886) as having been taken at the same locality. These latter appear as follows in the same work:

"Phyllodactylus tuberculosus Weigmann

2688 Mazatlan Hr. Salmin 1870

2689 Mazatlan Hr. Salmin 1870 (2 ex.)

2690 Mazatlan Hr. Salmin 1870 (3 ex.)

Phyllodactylus galapagensis Peters

3257 Mazatlan Hr. Salmin 1871"

The presence of this latter species seems to be an error of identification or of locality—possibly both.

The possibility that the name "Mazatlan" refers to some other locality has been considered. In Mexico there is a "Mazatlán" in Jalisco and one near Chilpancingo, Guerrero. In the state of Oaxaca there is a Mazatlán San Cristobal near Teotitlan, and Mazatlán San Juan near Tehuantepec. There are at least two species of *Phyllodactylus* (*magnus* and *muralis*), known from this region and the present species *Sphaerodactylus torquatus* likewise occurs there. Whether Hr. Salmin ever visited Oaxaca or obtained specimens from there I cannot say. In other works of Strauch I find specimens accredited to Salmin at about this time from Montevideo and Neu-Freiburg.

If this material can be examined and the actual identity of the two *Phyllodactylus* determined it may be possible to fix the type locality of *torquatus* with greater certainty. I very strongly suspect the locality, if intended for Mazatlán, Sinaloa, is either incorrect or the presence of the species there is to be accounted for by introduction by man.

Sphaerodactylus glaucus Cope

Sphaerodactylus glaucus Cope, Proc. Acad. Nat. Sci. Philadelphia, Oct. 1865, pp. 192-193 (type locality, near Mérida, Yucatán; Comision Cientifica under Arthur Schott, coll.; several specimens); Cope, *ibid.*, May 1866, p. 125 (types mentioned as collected by Arthur Schott; and a specimen from Tabasco collected by Dr. Berendt); Cope, *ibid.*, Oct. 24, 1871, p. 216 (a specimen from Tehuantepec, "collected by the U. S. Expedition to survey the Isthmus of Tehuantepec, by T. Hale Street, M. D."); Bocourt, Mission Scientifique au Mexique et dans l'Amérique Central; Etude sur les Reptiles, Livr. 2, 1873, p. 46, (no specimens); Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876, p. 118; Bocourt, Journ. de Zool. Paris, vol. 5, 1876, p. 401 (Tehuantepec specimen collected by F. Sumichrast); Sumichrast, Bull. Soc. Zool. France for 1880, vol. 5, p. 178 (habits; Tehuantepec); and Sumichrast, La Nature, vol. 6, entrega 3, 1882, p. 35 ("de ambas costas de la República"); Boulenger, Catalogue of Lizards in the British Museum, (Natural History), vol. 1, 1885, p. 221, pl. 18, fig. 3 (figure showing end of snout, upper view $\times 2$; adult specimen from Verapas, Guatemala (low forest) and half grown from Veracruz, Mexico, collected by F. D. Godman and O. Salvin); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1886, p. 82 (records include Teapa in Tabasco, Belize and Stan Creek, British Honduras; Petén, Guatemala); Cope, Bull. U. S. Nat. Mus. No. 22, 1887, p. 27 (locality list); Strauch, Mem. Acad. Imp. Sci. St. Petersburg, ser. 7, vol. 35, No. 2, May 1886, p. 35 ("No. 4292, Fundori? Hr. H. Shilling 1876"); Dugès, La Nature, 2d ser. vol. 2, pt. 2, 1896, 479, 484 (occurs in "Tierra Caliente"); Gadow, Proc. Zool. Soc. London, June 6, 1905, p. 194, 211 ("Sphaerodactylus sends only three species into Mexico; *S. glaucus* to Salina Cruz [Oaxaca] and late the state of Veracruz, etc."); Barbour, Mem. Mus. Comp. Zool. Harvard College, vol. 47, No. 2, Dec. 1921, pp. 240-241, (lists types, and redescribes one ecotype, M. C. Z. No. 12,570 formerly part U. S. N. M. No. 6,572); Allen, Copeia, No. 169, 1928, p. 98-99 (specimen of

uncertain provenance, carried in bananas); Barbour and Loveridge, Bull. Mus. Comp. Zool. Harvard Coll. 49, No. 10, 1929, p. 242 (condition of cotype); Gaige, Carnegie Institution Washington Publication No. 457, 1936, p. 295 (color description of one specimen from Tuxtepec Camp, Campeche); Smith, Occ. Papers Mus. Zool. Univ. Michigan, No. 826, Oct. 21, 1938, p. 13 (Part.) (specimens from Campeche): Ciudad del Carmen (10), Balchacaj (72), Apasote (1); Hartweg and Oliver, Misc. Publ. Mus. Zool. Univ. Michigan, No. 47, July 13, 1940, p. 14, (part.) (56 specimens; vicinity of Tehuantepec; Quiengola Mountain "all except 3 of the specimens seem to be typical *glaucus*. The three each have a dark collar on the neck)."

The rather brief type description of this species follows.

"Sphaerodactylus glaucus.

Dorsal scales very small, but flat, rounded, smooth; about ninety series round the body; abdominals larger, rounded, about forty-four rows from vent to axilla, continued larger on under side of tail (not reproduced in this specimen). Labials $\frac{4}{4}$, three scales bordering mental. Supraorbital mucro (*sic*) present, orbit equal from its border to, or little beyond, nostril; muzzle and front gradually acuminate. Auricular meatus smaller than digital palette. Above light brown, "greenish stone color or *glaucus*" in life, with minute paler spots and dark vermiculations; below whitish. Tail in life orange, more intense toward tip; in spirits with two yellow black-edged spots near tip, and one on each side the origin. Limbs and digits annulated with yellow, black bordered.

Muzzle to axilla, 5.5 lines; Muzzle to vent, 11.6 lines; vent to end of tail, 10.4 lines.

Habitat.—Near Merida, Yucatan. Coll. Comision Cientifica under Arthur Schott.

Allied to the cinereus and sputator, and somewhat intermediate between them. The second from Mexico."

The coloration of the young and half grown specimen (after preservation in formalin and alcohol) is of a somewhat uniform brownish, variable in shade, but growing lighter on the sides and gradually merging in the cream white of the venter. Anterior to a line joining the point of insertion of the arms is a median dark spot, flanked on each side with a cream spot; on each side of the body are two indistinct series of tiny cream spots; usually five or six are discernible and these tend to alternate with one another. There may be a more or less indistinct medial hair-line of darker pigment on occiput and also a hair-line on each side running back from eye on the occiput; some specimens (all perhaps to a greater or lesser degree) show an indefinite, darker canthal line which extends behind the eye on to the side of neck. Labials, both upper and lower, with darker areas.

On the arm there is a distinct cream spot on the elbow and a

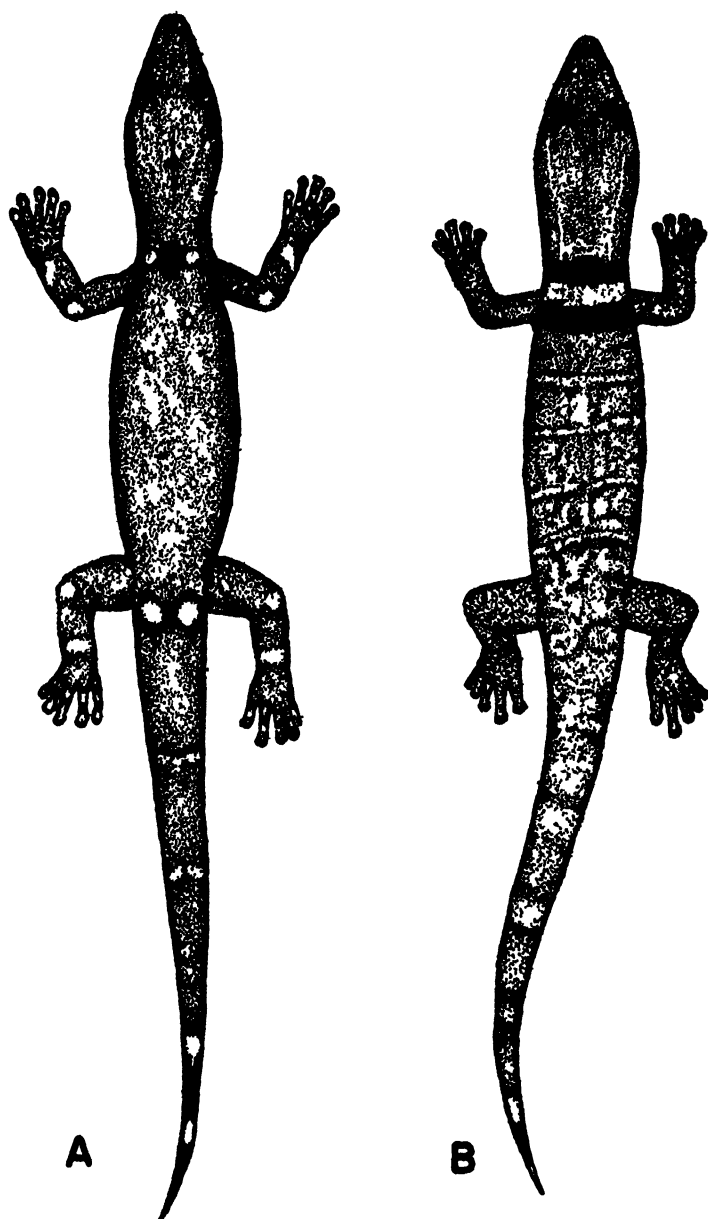


FIG. 2. A, *Sphaerodactylus glaucus* Cope. Somewhat diagrammatic showing the juvenile color pattern. Much enlarged. B, *Sphaerodactylus torquatus* Strauch. Somewhat diagrammatic, showing the juvenile color pattern. Much enlarged.

cream spot on the outer face of the arm; the fingers are annulated with cream at the joints. The leg has a knee spot of cream and a spot almost forming a band about middle of the lower part of leg. There are cream spots or annulations at the toe joints.

At the base of the tail there are two rounded spots of cream, variable in distinctness; toward the tip, when the tail is complete, there are two cream bands bordered by black on each side; occasionally whitish flecks are discernible toward the base. Ventrally on the tail the enlarged scales are cream at the base of the tail and in older specimens the color may extend to the tip; the flanking scales on each side are pigmented and this pigment may encroach slightly on the median series. The side of the head and neck is usually darker than the dorsal part of the head. The line bordering the dorsolateral darker stripe or line, may be lighter than the dorsal parts as a whole, suggesting a dim line running back from eye. There are indications of minute lighter dots scattered on the back.

In most if not all older specimens the spot on the shoulders is narrowed and lengthened somewhat, and the cream spots bordering it may be dim or altogether lost. The banding of the tail will be lost except that there usually remains one or two terminal cream and dark stripes usually less intense than in the young. (Note Fig. 2, showing markings of the young.)

The coloration in life differs somewhat from that of the preserved specimens. The cream spots are usually described as orange, reddish orange or pale red especially on tail. The general dorsal coloration is greenish gray or gray brown.

Mrs. Helen T. Gaige (1936) has described a specimen identified as *Sphaerodactylus glaucus* from Tuxpena Camp, Campeche as follows:

"Color gray with a single large black spot just behind the nape, followed by a spot lighter than the ground-color edged with two smaller black spots posteriorly; two conspicuous black dorsal spots between the hind legs, followed by a light spot; sides of neck with longitudinal stripes of gray. Nape with three converging dark longitudinal stripes; a faint indication of a darker gray stripe between fore and hind leg."

The present known distribution of the form in Mexico includes Yucatán, Campeche, Tabasco, Oaxaca and Veracruz. The most northern record is on the Jalapa-Veracruz highway about 20 miles from the city of Veracruz. I obtained the specimen from the bark of a small tree at the edge of a lagoon.

CONCLUSION

Of the four species of the genus *Sphaerodactylus* described from actual or presumed type localities in Mexico, *Sphaerodactylus glaucus* and *Sphaerodactylus torquatus* must be regarded as valid forms, since each is known from specimens unquestionably originating in southern Mexico. Despite the fact that the types of *Sphaerodactylus anthracinus* were reputed to come from Mexico and a specimen has been reported by Peters from Puebla, its presence in Mexico must be verified before it can have a certain place on Mexican faunal lists. Concerning *Sphaerodactylus inornatus*, Boulenger regarded it a synonym of *S. glaucus* and Barbour, a synonym of *lineolatus* and as coming from some locality not Mexican. Until the type is reexamined the status of this form must remain in question.

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Fossil and Living Pupillidae (*Gastropoda: Pulmonata*) in Kansas

By DOROTHEA S. FRANZEN and A. BYRON LEONARD

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ABSTRACT: The family Pupillidae (Gastropoda: Pulmonata) in Kansas and nearby areas is studied from the earliest known occurrence in the lower Pliocene Laverne Formation to and including the living pupillid faunule. The family is not yet known from the middle Pliocene of this region, but is reported from several strata of the Pliocene and Pleistocene.

The family Pupillidae, as now known, is represented in the area studied by 5 genera, including in all 33 species, as follows: genus *Gastrocopta*, 14 fossil and living species and subspecies; genus *Vertigo*, 10 fossil and living species and subspecies; genus *Pupilla*, 3 fossil species and subspecies, genus *Pupoides*, 3 fossil and living species; and the genus *Columella*, represented by 3 fossil species. Two new species of *Gastrocopta* are described, both from deposits of Blancan age.

The paleoecology of the various horizons studied is discussed; the deductions are based upon a consideration of reported floras and vertebrate faunas, together with the known molluscan faunules.

The vertical distribution of the pupillid faunules is reported and discussed. Faunal successions revealed indicate specific pupillid faunules for various horizons as follows: *Gastrocopta riograndensis* and *G. anterides*, known only from the lower Pliocene Laverne Formation; a close faunal relationship between the Saw Rock Canyon deposits (upper Pliocene?, Hibbard, 1948, personal communication) and the beds assigned to the Blancan age is demonstrated, since 5 of the 6 pupillids known from the aggregate faunule of these beds occur both in the Saw Rock Canyon deposits and the Blancan beds. *Gastrocopta paracristata* and *Vertigo hibbardi* are known from the Saw Rock Canyon as well as from beds of Blancan age, *Gastrocopta rezroadensis* is known only from beds now assigned to the Blancan, while the remaining pupillids of these beds are known through the Pleistocene and Recent faunules. Early Pleistocene faunules are characterized by the occurrence of *Gastrocopta proarmifera*, *G. falcis*, *Pupilla muscorum sinistra*, *Columella tridentata*, and *Vertigo gouldii*, and by the first appearance of *Pupilla muscorum*, which is also found in late Pleistocene faunules. Late Pleistocene pupillid faunules are characterized by the occurrence of *Vertigo hannai*, *V. elatior*, *V. gouldii paradoxa*, *Columella hasta* and *C. alticola*, *Pupilla blandi*, and by the first appearance of *Gastrocopta armifera*, *Pupoides hordaceus*, and *Vertigo modesta*. Four species are apparently restricted to the living pupillid faunule of Kansas, these are *Gastrocopta corticaria*, *G. pellucida hordeacella*, *Vertigo tridentata*, and *Pupoides inornatus*.

The status of *Gastrocopta armifera abbreviata*, *G. procera sterkiana*, *G. p. mcclunghi*, and the reported species of *Pupilla* are discussed, and the errors in previously published literature on Kansas mollusca are corrected.

INTRODUCTION

INTENSIVE and critical studies of the molluscan fauna of Kansas and the nearby states of Oklahoma, Missouri, and Nebraska have not been made previously, although the molluscan animals of Kansas have been given some attention by biologists for many years.

An early series of surveys of the flora and fauna of Kansas was sponsored by F. W. Cragin of Washburn College. Cragin was also editor of a scientific journal, the *Bulletin of the Washburn Laboratory of Natural History*, published 1884-1890 by the Natural History Department of Washburn College. In the second number of the *Bulletin*, R. Ellsworth Call (1885, pp. 48-49) reported a new species of *Unio* from Kansas. Succeeding studies of fresh-water mollusks were conducted by Call, who in the second number of the *Bulletin* (1885a, 49-51) published on the fresh-water bivalves and (1885b, 51-54) on the fresh-water univalves of northeastern Kansas. In the third number, the report by Call (1885c, pp. 93-97) treated of mollusks occurring in central and southeastern Kansas. The account by Call in the fourth number (1885d, pp. 115-124) included species not previously reported from Kansas and new locality records for previously reported species of lamellibranchs, as well as a study of aquatic gastropods. A fifth report by Call (1886, pp. 177-184) included a study of the molluscan faunule of Crooked Creek, Ford County, a comparison of the mollusks of the Arkansas River drainage in Kansas with that of the Ohio River, and additions to previous accounts of species occurring in Kansas as well as new localities for previously reported species. In the seventh number of the *Bulletin*, Call (1886a, pp. 201-206) reported on a study he made of the terrestrial molluscan fauna of the state. The final contribution by Call to the knowledge of the molluscan fauna of Kansas, was a study of pelecypods, aquatic and terrestrial gastropods (1887, pp. 11-25). W. G. Binney and Arthur F. Gray (1885, pp. 55-56) listed land shells of northeastern Kansas. Their report was comprised of a list of species with locality data. Richard E. Scammon studied the Kansas *Unios* and published "The Unionidae of Kansas" (1906, pp. 279-373) which is an extensive account including reports of 61 species and 5 subspecies. Ferris (1907, pp. 37-38) described a new subspecies of terrestrial snail occurring in Kansas.

G. Dallas Hanna (1909, pp. 81-82, 94-96) published a list of aquatic and terrestrial gastropods he had collected from Douglas

County. In a study of the genus *Sphyradium* [now *Columella*], Hanna (1911, pp. 372-373) described a new species obtained from a Pleistocene deposit in northwestern Kansas. A few years later the first report of a Pleistocene molluscan faunule from northwestern (Phillips County) Kansas was published by Hanna and Johnston (1913, pp. 111-121). This was later supplemented by a report by Hanna (1920, pp. 17-19) of the Pleistocene mollusks of Wallace County, Kansas. This was Hanna's final paper concerning Kansas mollusks.

A period of approximately twenty years elapsed before studies of Kansas mollusks were resumed. Doctor Claude W. Hibbard of the Museum of Natural History, University of Kansas, in studying vertebrate paleontology, found shells of mollusks associated with fossil vertebrates in Pleistocene and Pliocene beds in southwestern Kansas. He was interested in these shells insofar as they were of value in determining the ages of various strata of the several geologic formations he was encountering. He sent some specimens to Doctor Frank C. Baker who identified the shells of known species and described two new species (Baker, 1938, pp. 126-131). This molluscan faunule was listed by Hibbard (1941, p. 265) in a paper treating of the Rexroad fauna of southwestern Kansas. Another collection of shells was sent to Mr. Calvin Goodrich of the University of Michigan who identified the snails and listed them in *The Nautilus* (1940, pp. 77-79). This list appeared again in a subsequent paper by Hibbard (1940, p. 418) in a study of a Pleistocene fauna known as the Jones Fauna.

Leonard studied and identified the shells occurring in several Pleistocene beds and listed them in conjunction with physiographic and faunal studies of Kansas Pleistocene deposits (Frye, Leonard, and Hibbard, 1943, pp. 40-42). The list of mollusks of the Rezabek faunule which appeared in the previous paper, was repeated by Hibbard (1943, p. 236) and the list of mollusks of the Rexroad faunule, also of the same previous paper, appeared again in a stratigraphic and paleontological study of the Meade Basin (Frye, Hibbard, 1943, p. 408).

The study of Pleistocene deposits, and consequently the molluscan faunules of the deposits, was projected into northwestern Kansas following Doctor Maxim K. Elias' study (1931, pp. 163-180) and redefinition of the Sanborn Formation. Physiographic and vertebrate and molluscan faunal studies were conducted and published by Leonard and Frye (1943, pp. 453-462) and Hibbard, Frye, and Leonard (1944, pp. 1-28).

In the meantime, studies of the Recent molluscan fauna of the state of Kansas were resumed. Franzen and Leonard (1942, pp. 334-348) published a report of the aquatic and terrestrial gastropods occurring in Kingman County. A molluscan faunal study was made of the Wakarusa River Valley and published by Franzen and Leonard (1943, pp. 363-439). Alice E. Leonard collected Recent gastropods and pelecypods from Meade and Clark counties and reported them with a list of the associated flora (1943, pp. 226-240). Additions to the previously reported snails occurring in Kansas was made by Franzen (1944, pp. 261-273). Leonard and Leonard (1946, pp. 115-122) reported the pelecypods and gastropods they collected from watercourses in Greenwood County, Kansas.

Henderson (1924) compiled an annotated and somewhat critical list of the mollusks of Colorado and neighboring mountain states, and Doctor Henry A. Pilsbry, of the Academy of Natural Sciences, of Philadelphia, in his series of excellent and well-known monographs, has been concerned with various groups of snails in the southwestern, southern, and eastern states, but little was added to a knowledge of the Kansas fauna by these studies. It is obvious, since previous studies on the Kansas molluscan fauna have been largely uncritical lists, that much remains to be learned regarding the relationships of the fauna in this area to the fauna of surrounding regions. It is equally obvious, in the light of the nature of most of the previous studies on Kansas mollusca, that critical studies should reveal hitherto undiscovered errors and gaps of information concerning these animals in this region.

The present studies were undertaken in an effort to remedy this deficiency in the knowledge of the molluscan fauna of this plains-border and plains province, at least with respect to the members of the gastropod family Pupillidae. This family is here represented by five genera, comprising a total of 33 species and subspecies.

Pupillid snails are small, terrestrial animals, essentially inhabitants of northern continents, however, they have become widely dispersed over the entire inhabitable earth. They are, generally speaking, endowed with a high degree of tolerance for variations in ecological conditions. Their shells are structurally strong, and may be recovered in excellent condition from geologic deposits. Furthermore, they are animals which produce such highly differentiated shells that the shell characters afford the best means of arranging the animals in the scheme of zoölogical classification, which is certainly not true of snails in general. This view is strongly supported

by Baker (in Pilsbry, 1935, Vol. 28, pt. 112, p. 191) an eminent American authority on the anatomy of gastropods, in a review of the anatomy of the Pupillidae and related groups, where he states ". . . deductions based on the animal alone would be weak and this would be especially true of a group in which the shell characters, so far as my slight knowledge goes, appear manifest, while those of the soft parts are difficult to study and still more so to evaluate."

The plains province, of which Kansas is a part, has within it many sedimentary deposits of upper Tertiary and Pleistocene age which frequently contain the well-preserved shells of a varied molluscan fauna, including many examples of Pupillidae. Since much of the pupillid faunule of Kansas is known only from the shells recovered from such deposits, the fortunate fact that the shells of this group of snails are so useful in arriving at deductions concerning the zoological relationships of these animals, makes it possible to draw rather safe conclusions concerning the faunal succession, and vertical, as well as horizontal relationships among these snails.

The pupillids in this study include those obtained from gastropod faunules recovered from deposits ranging in age from Lower Pliocene to late Pleistocene, together with collections of the Recent pupillid faunule of Kansas.

The Pleistocene deposits in Kansas from which the pupillids of this study have been taken include three formations: the Sanborn Formation (Elias, 1931, pp. 163-180), the Kingsdown Silt Formation (Smith, 1940, pp. 111-116) and the Meade Formation (Cragin, 1896, p. 53; Hibbard, 1944, p. 709). Pupillids have been taken also from the Rexroad Formation, the Big Springs Ranch deposit and the Fox Canyon deposit. These beds have been assigned to the Blancan age (Elias et al, 1944, pp. 270-271). This is a provisional age term to which are assigned beds of undetermined ages overlying undoubted Pliocene beds and underlying beds of undoubted Pleistocene age. Pupillids of Upper Pliocene (?) age have been collected from the Saw Rock Canyon deposits.

The beds belonging to the Laverne Formation from which pupillids included in the study were collected, lie in Beaver County, Oklahoma, a county adjoining Meade and Clark counties, Kansas. Doctor Bertrand Schultz, Director Nebraska State Museum, generously loaned to the Museum of Natural History, University of Kansas, series of pupillids from Nebraska Pleistocene beds; these also have been included in this study.

In the following outline are listed the deposits, and their localities,

from which pupillids have been taken. The deposits are listed according to formations and assigned ages. References are made only to the latest publications which, in all cases, contain citations to earlier literature.

UPPER PLEISTOCENE

Sanborn Formation, Northwestern Kansas (Leonard and Frye, 1948, pp. 453-462, Text figs. 1, 2; figs. 1, 2).

Kingsdown Silt Formation (Hibbard, 1944, pp. 745-749). Upper Kingsdown.

Pyle Ranch, Clark County, S 13, T 30 S, R 23 W, 12 mi. E of Minneola (Hibbard, 1944, pp. 749-750).

Jones Sink, Locality number 13, Meade County (Hibbard, 1940, p. 417), S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E of Meade.

XI Ranch, Locality number 7 (Hibbard, unpublished), 15 mi. S, 7 mi. W of Meade, S 33, T 34 S, R 29 W.

Rezabek Quarry, Lincoln County, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln (Hibbard, 1943, p. 236).

MIDDLE PLEISTOCENE

Meade Formation, below Pearlette Ash (Hibbard, 1944, pp. 718-719). The following are equivalents (Hibbard, 1944, pp. 740-744):

Pyle Ranch, in part, Clark County, S 13, T 30 S, R 23 W, 12 mi. E of Minneola (Hibbard, 1944, pp. 718-719). Tobin deposit, Russell County, S 35, T 14 S, R 11 W, 5¼ mi. S, 18 mi. E of Russell (Hibbard, 1944, p. 734). Wilson Valley deposit, Lincoln County, S 28, T 13 S, R 10 W, 9 mi. S, 15 mi. W of Lincoln (Hibbard, 1944, p. 738). Cudahy Volcanic Ash Pit, Type locality of the fauna, Meade County, S 2, T 31 S, R 28 W, 6 mi. N of Meade (Hibbard, 1944, pp. 718-719).

Sunbrite (included in Cudahy), Meade County, S 26, T 31 S, R 28 W (Hibbard, 1944, p. 719).

BLANCAN (Elias et. al., 1945, pp. 270-271).

Rexroad Formation or Equivalents

Rexroad Ranch, Locality number 3, Meade County (Hibbard, 1941, p. 265), SW¼, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade.

Big Springs Ranch, Locality number 24, Meade County (Hibbard, unpublished), NW¼, NW¼, S 19, T 32 S, R 28 W, 2 mi. S, 4 mi. W of Meade.

Fox Canyon, Locality number 24, Meade County (Hibbard, unpublished), S 35, T 34, R 30 W, 17 mi. S, 12 mi. W of Meade.

UPPER PLOCENE?

Saw Rock Canyon, Seward County S 35, T 34 S, R 31 W, 14 mi. E of Liberal.

LOWER PLOCENE

Laverns Formation, Beaver County, Oklahoma (Frye and Hibbard, 1941, pp. 398-403, Fig. 3).

With the exception of a few series of Kansas pupillids which are in the molluscan collection of the United States National Museum, the shells of Kansas and of the Laverne Formation are in the Molluscan Collection of the Museum of Natural History, University of Kansas. This collection was augmented a few years ago by the incorporation of G. Dallas Hanna's private collection of gastropods of Kansas.

In proceeding with this study, the authors have studied the pupillid gastropods included in the collection of the Museum of Natural History of the University of Kansas, totaling about 15,000 shells. Comparative studies were made, including those with holotypes, paratypes, and topotypes where possible, at the Museum of Zoölogy, Ann Arbor, Michigan, the United States National Museum, Washington, D. C., at the Academy of Natural Sciences of Philadelphia, Philadelphia, and at the Carnegie Museum, Pittsburgh.

In this study of pupillids, fossil as well as Recent shells were used. Since only the shells were studied, criteria of taxonomy were established accordingly.

Certain pupillid shell characters are of specific significance. These include features such as the general shape of the shell as determined by the width relative to the height; the number, size and convexity of the whorls; the size of the ultimate whorl relative to the total height; ornamentation of the surface of the shell; the number, size, and location of the denticles; the absence or presence of the crest behind the peristome; and the nature of the umbilical opening. The constancy of occurrence or absence of these characters within a species are indications that they are morphological expressions of genetic significance, and are therefore of taxonomic value.

A species is here considered as being comprised of individuals in which any significant shell character or combination of several characters is constant and distinct within the limits of individual variation. These specific characters do not intergrade with the corresponding characters of another species of the genus, even though two species may have only minute morphological differences.

Characters of shells demonstrating wide ranges of individual variations which form a continuous and intergrading series in shells within a population and in localities distributed over the entire state,

and over a region in general, fossil as well as Recent, were considered as individual variants and not as specific or subspecific criteria.

A subspecies is here considered as a geographical group of individuals morphologically recognizable within a species. Two subspecies do not occupy the same geographical area except possibly within a restricted zone in which interbreeding takes place. A subspecies is a recognizable group but not as clearly defineable as a species because two related subspecies are not as completely distinct genetically as are two species of a genus. Characters separating two subspecies intergrade where the ranges of the subspecies meet.

DEFINITION OF SHELL CHARACTERS

Many of these terms are illustrated in fig 1

Aperture: the open end of the ultimate whorl. In pupillids denticles are frequently situated within the aperture.

Biarcuate aperture: an aperture whose palatal wall and peristome are indented to a greater or lesser degree.

Body whorl: the final whorl of a mature shell; same as the ultimate whorl.

Columella: the longitudinal axis of the shell around which the whorls are coiled.

Conic: shell with a spire tapering to a point producing a cone-shaped shell.

Costae: prominent riblets on the surface of the shell.

Crest: a linear callus situated on the ultimate whorl, behind and paralleling the peristome.

Cylindric: shell in which the whorls increase very slowly in size resulting in a shell more or less cylindrical in shape.

Denticles: calcareous excrescences within the aperture; number, size, and location of denticles is specific.

Everted aperture: aperture widely flaring toward the peristome.

Folds: denticles along the palatal wall of the aperture.

Upper palatal fold: a primary fold situated at the upper part of the palatal wall.

Suprapalatal fold: a low, secondary fold situated above the upper palatal fold. Sometimes wanting.

Lower palatal fold: a primary fold situated toward the base of the outer wall of the aperture.

Interpalatal fold: A secondary fold situated between the lower and upper palatal folds; frequently wanting.

Infrapalatal fold: a secondary fold situated below the lower palatal fold.

Basal fold: A low to rather high fold situated at the angle of the columellar and palatal walls. Position variable.

Height of shell: distance from apex to base of shell.

Immersed denticles: denticles located deeply within the aperture.

Imperforate: a shell whose columella has no opening at the base is said to be imperforate.

Lamellae: denticles located on the parietal wall or on the columellar side of the aperture.

Columellar lamella: the denticle situated at the base of the axis within the ultimate whorl.

Subcolumellar lamella: the denticle situated immediately below the columellar lamella; frequently partially fused with the columellar lamella.

Parietal lamella: one of the primary denticles situated on the parietal wall toward the columella.

Infraparietal lamella: a secondary, small lamella situated on the parietal wall between the parietal lamella and the columella.

Angular lamella: a primary denticle on the parietal wall near the outer wall of the aperture.

Nuclear whorl: the first one or one and one-half whorls of the shell; the embryonic whorl; forms the apex of the shell.

Palatal callus: a linear excrescence within the aperture, connecting the palatal folds and paralleling the peristome.

Palatal wall: that part of the wall of the aperture not bounded by any part of the ultimate whorl; the outer wall.

Perforate shell: a shell with an umbilical opening.

Parietal callus: the callus, thin or heavy, laid upon the parietal wall of the peristome and connecting the terminations of the peristome.

Parietal wall: the upper portion of the apertural wall formed by the base of the ultimate whorl.

Reflected peristome: peristome everted from the aperture.

Rimate shell: a shell whose umbilical opening is reduced to a fissure.

Spire: comprised of the whorls of the shell except the ultimate whorl.

Striations: parallel lines of sculpture on the shell.

Suture: the spiral indenture of the shell where a whorl comes in contact with the preceding whorl.

Umbilicus: the opening of the columella at the base of the shell.

Whorl: a complete revolution of the shell.

In order for one studying pupillids to be certain of making an accurate observation, it is necessary that an adequate light source be available and also that shells be dissected. Shell characters such as the size, shape, and position of the columellar lamella and of the longer palatal folds, are frequently not completely visible in an undissected shell.

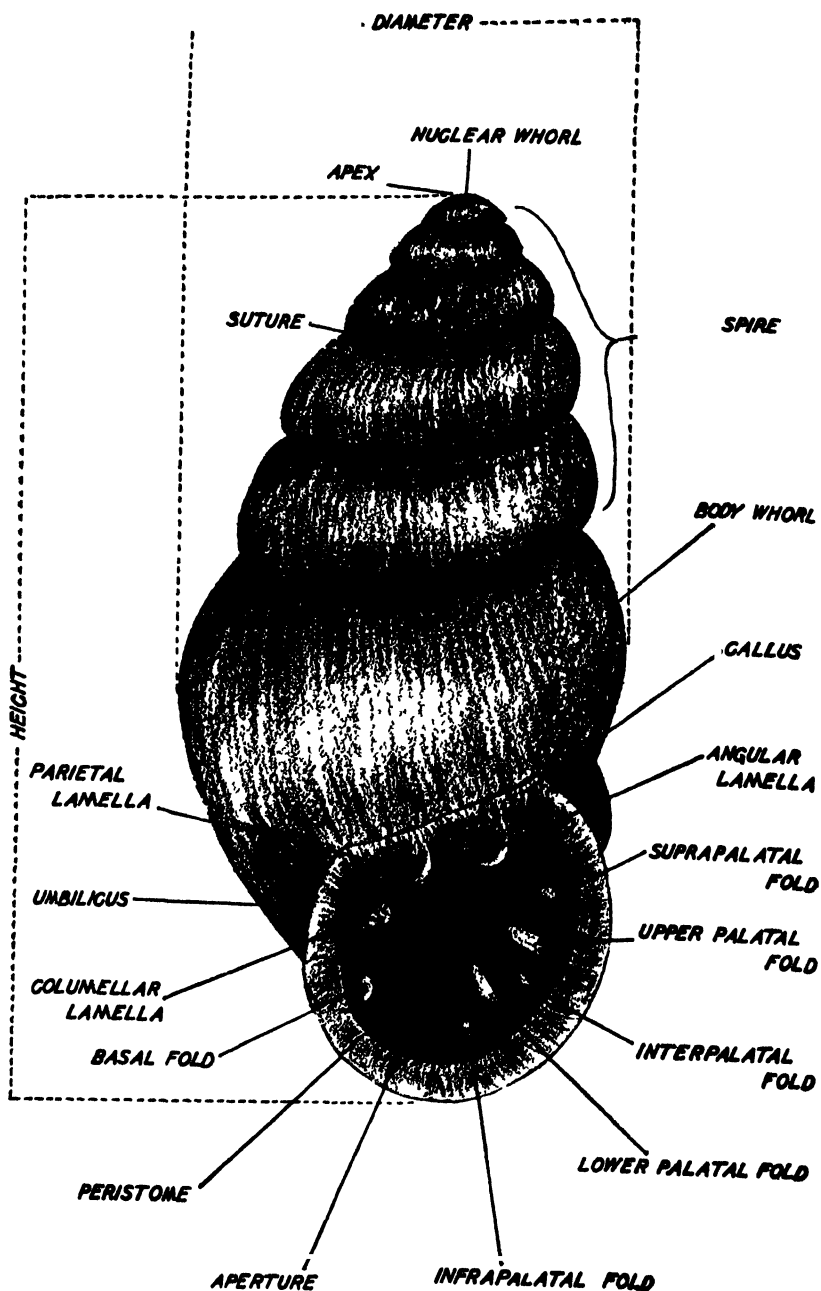


FIG. 1. Diagram of Named Parts of Gastropod Shell.

Family PUPILLIDAE Turton

Pupillidae Turton, *Manual of the Land and Fresh-water Shells of the British Islands*, 1881, p. 97. Pilsbry, 1916-1918, Vol. 24, pts. 98-96, pp. 1-880; 1918-1920, Vol. 25, pts. 97-100, pp. 1-404; 1920-1921, Vol. 26, pts. 101-104, pp. 1-254; 1922-1926, Vol. 27, pts. 105-108, pp. 1-869; 1927-1935, Vol. 28, pts. 109-112, pp. 1-226. Henderson, 1935, pp. 18, 148-154.

Characteristics of the shell: Shell elongate, whorls coiled in a spire; cylindrical, ovate to conic; color milky-white, auburn to brown, translucent to opaque; height 1.5 mm. to 5.8 mm.; whorls $4\frac{1}{2}$ to 9, compressed to inflated; aperture irregularly rounded to oval, dentate to secondarily edentulous; folds and lamellae 0 to 9; angular and parietal lamellae frequently concrescent; palatal folds varying in distance of immersion and frequently situated on a palatal callus; aperture narrowly to widely expanded; peristome narrowly to widely reflected; rimate to minutely and elongately perforate to roundly perforate.

Distribution:

Recent: Although the family Pupillidae inhabits mainly the Palaearctic Region, it is now represented in all of the continents and many islands. Palaearctic Region: North Atlantic Islands, Central Asia, Transcaucasus and Turkestan to N. China, Maritime Provinces of Siberia, Japan, Korea, China. Ethiopian Region: South Africa, Abyssinia, St. Helena, Mascarene Islands, Madagascar, Comoros. Oriental Region: India, Ceylon, Burma, Indo-China, Malay Peninsula, Indo-Malayan Islands, Phillipines, Java, Borneo. Australian Region: Austro-Malayan Islands, Melanesian Islands, Australia, Tasmania, Polynesia, Micronesia, Hawaiian Islands. Nearctic Region: Temperate North America, Mexico, Central America. Neotropical Region: West Indies, South America (Pilsbry, 1934, pp. 139-169).

Pleistocene: Kansas, Nebraska, Iowa, Illinois, etc.

Pliocene: Europe (Pilsbry, 1934, pp. 147-148). Kansas, Oklahoma.

Miocene: Europe (Pilsbry, 1934, pp. 147-148).

Oligocene: Europe (Pilsbry, 1934, pp. 147-148). Wyoming, Florida (Henderson, 1935, p. 13).

Eocene: Europe (Pilsbry, 1934, pp. 147-148). Wyoming, North Dakota (Henderson, 1935, p. 13).

Paleocene: Europe (Pilsbry, 1934, pp. 147-148). Alberta (Henderson, 1935, p. 13).

Permian: Ohio (Henderson, 1935, p. 13).

Upper Carboniferous: New Brunswick, Nova Scotia, Canada, Ohio, Illinois (Henderson, 1935, p. 13).

Center of dispersal: The region in which the family Pupillidae evolved and from which it dispersed is a matter of conjecture. According to Pilsbry (1934, pp. 139-144) several factors indicate Eurasia as the region from which the family radiated. Fifty genera

are recognized in the family Pupillidae. Of these, 38, living and fossil, are known from Eurasia. Thirty of these genera, 18 living and 12 fossil, occur in the western part of the Palaearctic Region and 15 genera, all living, occur in the Oriental Region. Three of the widely distributed genera are known from European Tertiary beds. The genus *Gastrocopta* is known from the Oligocene to the Pliocene of Germany; the genus *Pupilla* from the Upper Oligocene and Miocene of Central Europe; the genus *Vertigo* from Eocene and Pliocene in Europe (Pilsbry, 1934, p. 139).

These records do not represent the earliest occurrences of pupillids. The known pupillids of the European Tertiary are too specialized and resemble the modern forms too closely to be the early ancestral stock. Furthermore, since Pilsbry's study, Henderson (1935) has reported shells considered as pupillids from deposits as early as the Upper Carboniferous in North America. More paleontological data are needed before any conclusions can be drawn regarding ancestry and center of dispersal of the family Pupillidae.

KEY TO GENERA

1. Shell rimate to elongate and minutely perforate..... 2
 Shell roundly perforate *Columella*
2. Aperture not biarcuate 3
 Aperture biarcuate; angular and parietal lamellae never fused..... *Vertigo*
3. Angular and parietal lamellae always present; partially or completely fused,
 Gastrocopta 4
 Angular or parietal lamella or both frequently wanting, never fused.....
4. Ultimate whorl exceeding $\frac{1}{2}$ total height of shell..... *Pupoides*
 Ultimate whorl not exceeding $\frac{1}{2}$ of total height of shell..... *Pupilla*

Genus *Gastrocopta* Wollaston

Gastrocopta Wollaston, 1878, p. 615.

"*Leucochilus* Boettger, in von Martens, *Conchologische Mittheilungen*, I, 1881, p. 64. Not *Leucochila* von Martens, 1860.

Bifidaria Sterki, in Pilsbry, *Proc. Acad. Natural Sciences of Philadelphia*, 1891, p. 315, for *P. contracta* and *P. servilis*.—Sterki, *Nautilus* VI, p. 4, 1892, and p. 99, 1893.—Pilsbry, *Proc. A. N. S. Phila.* 1900, p. 590.—Dall, *Nautilus* XVII, p. 116, 1904, type *B. servilis* Gld. Includes also *Eubifidaria*, *Albinula*, *Vertigopsis* and *Privatula*, Sterki, 1893.

Immersens Pilsbry and Vanatta, 1900" (Pilsbry, 1916, Vol. 24, pt. 93, p. 6).

Gastrocopta, Pilsbry, 1916, Vol. 24, pt. 93, pp. 6-112, Plates 1-8, 10-20, 21—figs. 1-10. 1917, Vol. 24, pt. 94, pp. 112-172, Pl. 21, figs. 11-17, 22-24, 25—figs. 1-9, 12-15, Plates 26-27, 28—figs. 1-6, Pl. 29, figs. 8-10, Pl. 30. 1920, Vol. 25, pt. 100, p. 370. 1934, Vol. 28, pt. 110, pp. 63-73, Pl. 17, figs. 1, 2, 3-9, 10-19; Pl. 18, figs. 1, 2, 3, 5, 6; pt. 111, pp. 117-121, Pl. 22, figs. 1-6; pp. 141-143, text figs. 5, 8; pt. 112, pp. 203-204, Pl. 27, figs. 3-7.

Problems of nomenclature of the genus *Gastrocopta* are discussed by Pilsbry, 1916, pt. 93, p. 8.

Characteristics of the shell: Shell ovate to ovately conic; summit obtuse; total height 2.1 mm. to 5 mm.; whorls $4\frac{1}{2}$ -7, convex, irregularly and finely striate; rimate, minutely perforate; lamellae and folds 3-9; parietal lamellae 2-3, angular and parietal lamellae

partially fused, bilobed, or angular forming a spur anteriorly, completely fused, sinuous or sharply bent; palatal folds 0-6, frequently situated on a palatal callus; columellar lamella strongly or weakly developed; peristome expanding, usually reflected, adnate upon or continuous across parietal wall by a thin to heavy callus; low to prominent crest on ultimate whorl paralleling the peristome, frequently present.

Distribution:

Recent: One of the most widely distributed of the genera of Pupillidae; circumpolar; inhabiting Africa, India, China, Korea, Japan, islands between Asia and Australia, Australia, Africa, SW Arabia, North America, West Indies, South America (Pilsbry, 1934, pt. 111, pp. 137-160; 1935, pt. 112, pp. 160-169).

Pleistocene: Kansas and Nebraska

Blancan: Kansas

Pliocene: Lower Pliocene, Beaver County, Oklahoma; Pliocene in Kansas.

Pliocene of Germany (Pilsbry, 1916, pt. 93, p. 9).

Miocene: Germany (Pilsbry, 1916, pt. 93, p. 9).

Oligocene: U. Oligocene in Germany (Pilsbry, 1916, pt. 93, p. 9).

KEY TO SPECIES

1. Palatal folds prominent, on a callus..... 2
Palatal folds not on a callus..... 8
2. Parietal lamellae moderately large to large..... 3
Parietal lamellae small; parietal lamellae completely fused, tubercular,
G. tappaniana
3. Angulo-parietal lamellae fused 4
Angulo-parietal lamellae partially fused, divergent anteriorly..... 7
4. Angulo-parietal lamella fused, buttressed posteriorly; columellar lamella horizontal, turned down inwardly.....*G. anterides*
Angulo-parietal lamella fused, not buttressed posteriorly..... 5
5. Angulo-parietal lamella sinuous, not bifid anteriorly..... 6
Angulo-parietal lamella bent sharply at two points; columellar lamella large, subvertical*G. contracta*
6. Columellar lamella disk-shaped, large, extending full height of the ultimate whorl,
G. proarmifera
Columellar lamella large, recurved, not extending full height of the ultimate whorl*G. armifera*
7. Angulo-parietal lamella fused posteriorly, widely divergent anteriorly....*G. falcis*
Angulo-parietal lamella fused, slightly divergent anteriorly.....*G. holsingeri*
8. Parietal lamella small; angulo-parietal lamellae bilobed, straight; columellar lamella small, subvertical*G. corticaria*
Parietal lamellae large 9
9. Angular and parietal lamellae not fused.....*G. rezroadensis*
Angulo-parietal lamellae fused, partially or completely..... 10
10. Angulo-parietal lamellae sinuous, angular forming a spur anteriorly..... 11
Angulo-parietal lamellae completely fused, angular not forming a spur anteriorly.. 12
11. Lower palatal fold oblique, very deeply immersed.....*G. procera*
Lower palatal fold not oblique, deeply immersed.....*G. riograndensis*
12. Subcolumellar lamella present; lower palatal fold deeply immersed....*G. cristata*
Subcolumellar lamella wanting 13
13. Lower palatal fold not deeply immersed.....*G. paracristata*
Lower palatal fold deeply immersed.....*G. pellucida hordeacella*

STATE OF KANSAS

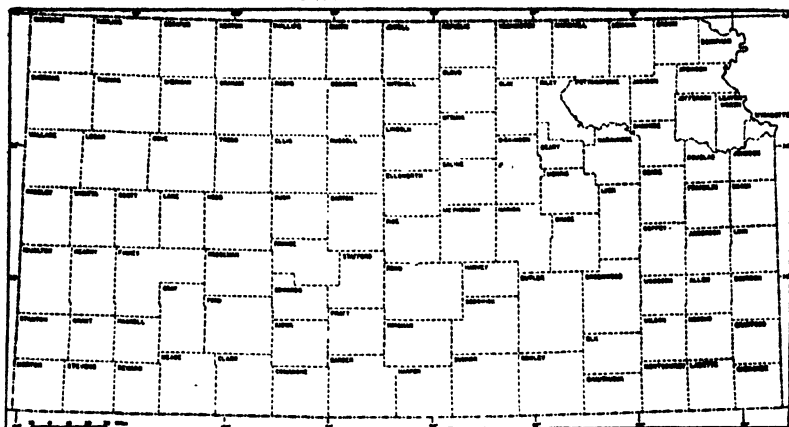


FIG. 2. Key to the counties in Kansas.

Gastrocopta proarmifera Leonard

Plate XVII, figs. 1, 2. Text fig. 3.

Gastrocopta proarmifera Leonard, 1946, pp. 20-22.

Description of the shell: "Shell perforate, rimate, ovate-oblong, summit obtusely conic. Whorls a little more than 6 in number, first $1\frac{1}{2}$ finely granular, remaining whorls finely and diagonally striate; whorls only slightly inflated, last whorl compressed around axis, subangulate below; suture moderately impressed. Aperture irregularly oval; peristome flared; lip thin and simple, reflected, adnate and continuous upon body whorl. A depressed, seamlike scar, behind peristome, indicates position of lower palatal plica. Lamellae 7 in number; a fused angulo-parietal, a columellar, a basal, lower palatal, upper palatal, and suprapalatal. The massiveness of the lamellae restricts the size of the orifice. The angular lamella arises from peristome above sinus, curves, and is deflected toward periphery, fused with the parietal at its lower termination; parietal heavy with rounded edge, bifurcate below, an elongate limb turns toward the periphery, a shorter, heavier limb curves toward the columella; columellar lamella, when viewed from in front, appears as $\frac{1}{2}$ of a slightly concave disc; it extends obliquely downward, the lower part most deeply immersed. Basal lamella almost obsolete, subcolumellar in position; palatal plicae on a low rounded callous; the lower palatal very deeply placed in cavity (above the termination of the parietal) heavy, bluntly chisel-shaped, transverse

in cavity; upper palatal lamella less deeply immersed, less than $\frac{1}{2}$ as large as lower palatal, termination rounded, and directed slightly toward the periphery; suprapalatal lamella small, nodular, located on lower border of sinulus. Lamellae and walls of aperture finely punctuate." (Leonard, 1946.)

Variations: The shells of a large series of paratypes varied only slightly. The only appreciable variant is the difference in height as is shown in the table of measurements below.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	4.08	2.16	1.6	1.4	6½
Paratype:	3.37	2.0	1.44	1.24	6¼
Paratype:	3.93	2.16	1.5	1.44	6½
Paratype:	3.96	2.16	1.6	1.44	6½

Habitat: This species is known only from Pleistocene deposits, therefore, its habitat is unknown. Since early Pleistocene times it has been replaced by *Gastrocopta armifera*.

Distribution:

Type locality: Russell County, Tobin deposit, S 35, T 14 S, R 11 W; 3 mi. SW of Wilson.

General Distribution: Pleistocene in Nebraska, Kansas.

Distribution in Kansas:

Pleistocene: Meade Formation: Type locality. Meade County: Cudahy Volcanic Ash Pit, S 2, T 31 S, R 28 W, 6 mi. N of Meade. Clark County; Pyle Ranch, S 20, T 13 S, R 10 W, 13 mi. E, $\frac{1}{2}$ mi. S of Minneola.

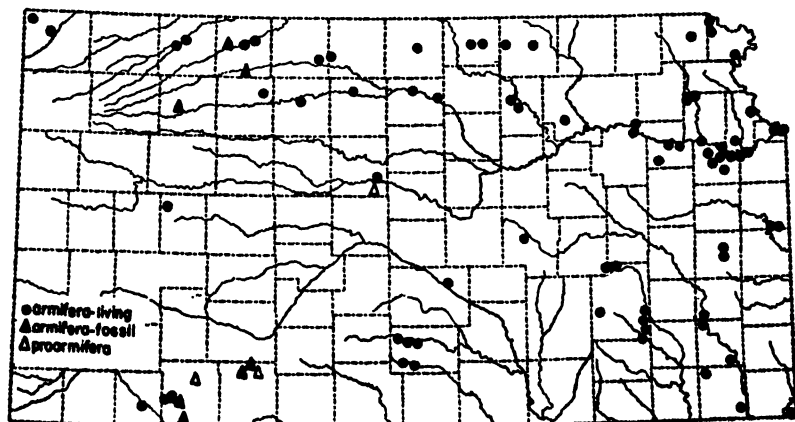


FIG. 3. Records of *Gastrocopta proarmifera* Leonard, and *G. armifera* (Say).

Gastrocopta armifera (Say)

Plate XVII, figs. 3, 4, 5. Text figure 3.

Pupa armifera Say,* 1821, p. 162; Binney and Gray, 1885, p. 56.*Bifidaria armifera*, Hanna, 1909, p. 94; Over, 1942, p. 8.*Gastrocopta armifera*, Pilsbry, 1916, Vol. 24, pt. 93, pp. 15-17, Pl. 1, figs. 1-4; Hanna, 1920, p. 19; Henderson, 1924, pp. 79, 130-131, fig. 32; Lugin, 1935, Table C, p. 212; Frye, Leonard and Hibbard, 1943, p. 41; Fransen and Leonard, 1943, pp. 416-416, Pl. XXXII, figs. 38, 39, text fig. 6.*Gastrocopta armifera abbreviata*, Goodrich, 1940, p. 77; Goodrich in Hibbard, 1940, p. 418; Fransen and Leonard, 1942, p. 339, Pl. I, fig. 4; Leonard and Frye, 1943, p. 457; Fransen and Leonard, 1943, pp. 416-417, Pl. XXXII, figs. 36, 37, text fig. 6; Leonard, 1943, pp. 238-239; Leonard and Leonard, 1946, p. 120.

Description of the shell: Shell large, largest of the genus represented in Kansas, fossil or Recent; oval; grayish white; glossy; rimate; whorls $5\frac{1}{2}$ to 7, slowly and regularly increasing in size; the $1\frac{1}{2}$ nuclear whorls finely granular, remaining whorls finely and irregularly striate; body whorl exceeding $\frac{1}{2}$ the total height, somewhat constricted at the base and expanding toward the peristome; aperture large, exceeding half the height of the ultimate whorl, rounded; denticles 6-7: a prominent, bifid, angulo-parietal situated at the center of the parietal wall; 4 folds situated on a low palatal callus, a low, tubercular suprapalatal, a prominent, elongate oblique upper palatal, a prominent elongate, lower palatal, highest point midway of its length, a tubercular basal; columella lamella triangular and projecting outwardly, Pl. III, figs. 4, 5, situated toward the base of the columella. Peristome narrowly reflected; terminations approaching and connected across parietal wall by a wide callus; margin sharp.

Variations: Several characters are subject to considerable variation. The height of the shell varies from 3.6 mm. to 5 mm. The columellar lamella varies in size from one occupying only the lower half of the columella of the apertural portion of the ultimate whorl to one extending the entire length of the apertural portion of the columella. When the columella lamella is of maximum length, it is also wider than in other shells, see Pl. III, figs. 4, 5. The basal fold varies from a prominent tubercular tooth to one perceptible only as a remnant; frequently it is entirely wanting. These several variations occur among shells of a single population, and in the various Kansas localities, among fossil as well as Recent populations. Because all intermediate steps between the two extremes of a character occur at one locality, it is impossible to subdivide a series satis-

* The synonymies listed in this study include only references to type description: to Pilsbry's monographic treatment of the pupillidae in the *Manual of Conchology* (1916-1935), and to papers dealing with pupillids of Kansas and nearby areas.

factorily into several subspecies. Therefore, the shells from Kansas which previously have been identified as *Gastrocopta armifera* and *G. a. abbreviata* are here designated only as *G. armifera*.

Shells of this species in the Museum of Natural History, University of Kansas, have been compared by the author with those of the same species in the Academy of Natural Sciences of Philadelphia and with Sterki's collection in the Carnegie Museum of Pittsburgh. The variations in the shells in Philadelphia and Pittsburgh correspond closely to those of shells in the collection at the University of Kansas. In a conversation, Doctor H. A. Pilsbry (April 30, 1946) expressed doubt of the validity of the several subspecies into which Sterki has divided *G. armifera*. However, since the present study is restricted to only a small part of North America, no attempt is made to determine the status of the alleged subspecies of *G. armifera* from other parts of North America.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
3.6	2.1	1.4	1.35	5½
3.9	2.2	1.6	1.4	5½
4.4	2.4	1.8	1.4	6
4.7	2.5	1.8	1.5	6½
5.0	2.5	1.8	1.45	7

Habitat: *Gastrocopta armifera* is a gregarious species occurring commonly on wooded slopes, near or removed from a stream. It is to be found under dead wood, limestone rocks, or light cover of leaf mold or other debris. *G. armifera* frequently occurs under boards or rocks in gardens.

Distribution:

Type locality: Pennsylvania.

General distribution: Quebec, eastern United States to northern Florida, west to Alberta, Dakota, Colorado, southeastern New Mexico and to the mouth of the Pecos River in Texas (Pilsbry, 1916, Vol. 24, pt. 93, p. 18).

Distribution in Kansas:

Recent: Ubiquitous in Kansas.

Pleistocene: Clark County: Pyle Ranch faunule, above the Pearlette Ash (Cragin, 1896, p. 54, from Hibbard, 1944, p. 742), S 13, T 30 S, R 23 W, 13 mi. E. ½ mi. S of Minneola; Taylor Ranch, NE¼, S 20, T 30 S, R 23 W, ½ mi. S. 9 mi. E of Minneola, relation to Pearlette Ash not known. Meade County, Jones Sink, Locality number 13 (Hibbard, 1940, p. 417), S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E. of Meade; XI Ranch deposit, S 33, T 34 S, R 29 W, 15 mi. S, 7 mi. W of Meade. Sanborn Formation: Norton County; NW¼, NE¼ S 18, T 3 S, R 23 W.

Gastrocopta armifera is distributed in North America in regions of diverse climates. It is the most widely distributed and numerous of the pupillids in the Recent fauna of Kansas. It is represented also in Upper Pleistocene beds of Kansas and Nebraska. Apparently this species has not been receding from Kansas since Pleistocene times.

The widespread distribution in North America, including Kansas in general, indicates that this species is tolerant of and adaptable to various climatic conditions. In the prolonged dry, hot summer months, *G. armifera* is able to aestivate, making possible its survival in Kansas, especially in the western part of the state, where the summer droughts are often severe.

Gastrocopta armifera has not been found in deposits below the Pearlette Ash. In the Tobin, Wilson Valley, and Pyle Ranch beds of the Meade Formation, *Gastrocopta proarmifera* (Leonard, 1946) occurs in large numbers where *G. armifera* is not known to occur.

Gastrocopta contracta (Say)

Plate XVIII, fig. 9. Text figure 4.

Pupa contracta Say, 1822, p. 374.

Pupilla contracta, Call, 1886, p. 206.

Bifidaria contracta, Hanna, 1909, p. 94.

Gastrocopta contracta, Pilsbry, 1916, Vol. 24, pt. 93, pp. 22-23, Pl. 2, figs. 9, 10, 11, 12; Lugin, 1935, p. 212, Table C; Franzen and Leonard, 1942, p. 839, Pl. I, fig. 2; Franzen and Leonard, 1943, p. 417, Pl. XXXII, figs. 34, 35, Text fig. 6; Frye, Leonard, and Hibbard, 1943, pp. 41, 42; Leonard and Leonard, 1946, p. 120.

Description of the shell: Shell ovate-conic, summit convex, moderate in size for the genus, height varying from 2.1 mm. to 3.0 mm.; rimate, minutely perforate; living shells bluish-milky, glossy, semi-translucent; dead shells white, opaque; whorls $4\frac{1}{2}$ to 6, convex, increasing gradually in size; body whorl slightly more than half of total height of shell; $1\frac{1}{2}$ nuclear whorls finely granular; remaining whorls finely and irregularly striate; last half of body whorl sharply turned toward aperture, contracted at the base and rapidly expanding toward the aperture; a crest varying from one well-developed to one scarcely perceptible, paralleling the peristome and removed from it by a wide groove; aperture triangularly rounded, apex of triangle forming the base of the aperture; folds and lamellae large, almost completely filling the aperture; a fused angulo-parietal lamella, large, the angular portion continuous with the outer lip of the peristome, lamelliform and folded toward the outer lip, midway bent at a right angle toward the angular side and terminating by a low appendage directed dorsally at a right angle; upper palatal

fold immersed, tubercular, situated on a low palatal callus; lower palatal fold slightly elongate, oblique, deeply immersed, columellar lamella large, lamelliform, descending inwardly; peristome broadly expanded and reflected, thin, continuous, adnate upon the ultimate whorl; a heavy, elongate callus situated along the inner margin of the columellar side of the peristome and paralleling the peristome; margin sharp.

Variations: Only a few of the characters of this species are variable. The variations in heights and widths of the shells are not in the same proportions, resulting in variations in shape. The crest behind the peristome varies from one very prominent to one scarcely perceptible. The number of whorls varies from $4\frac{1}{2}$ to 6. Kansas shells of this species agree with those in the collection of the Academy of Natural Sciences of Philadelphia, including shells from north-eastern United States.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.1	1.2	0.9	0.8	5
2.3	1.25	0.7	0.7	$5\frac{1}{2}$
2.6	1.4	1.0	0.9	5
2.8	1.6	1.1	1.0	$5\frac{1}{2}$
3.0	1.5	1.1	0.9	6

Habitat: On shaded slopes along the watercourses, under dead wood, leaf mold and grass.

Distribution:

Type locality: Occoquan, Virginia.

General distribution: Ontario and Manitoba, Canada; Maine south to Florida; Veracruz, Mexico; Jamaica; west to Clay county, South Dakota; Kansas; Lawton, Oklahoma. Pleistocene in Nebraska, Kansas.

Distribution in Kansas:

Recent: Northeastern Kansas, along the courses of the Missouri and Kansas Rivers; southeastern Kansas, along the courses of the Marais des Cygnes, Neosha, and Verdigris rivers; southcentral Kansas, along the course of the Arkansas River.

Pleistocene: Lincoln County: Rezabek faunule, NE $\frac{1}{4}$, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln; Wilson Valley faunule, NE $\frac{1}{4}$, S 28, T 13 S, R 10 W, 9 mi. S, 15 mi. W of Lincoln.

Gastrocopta contracta is unknown in Kansas west of northwestern Kingman County where it occurs along the South Fork of the Ninnescah River and in northcentral Reno County along the Arkansas River. These two localities are west of the previously known midwestern occurrences, namely, Clay County, South Dakota, and Payne County, Oklahoma (Pilsbry, 1916, pt. 93, Vol. 24, p. 22).

However, the westernmost range in Texas, the mouth of the Pecos River, lies west of these two Kansas localities.

In the Pleistocene deposits of Kansas, *G. contracta* has been found only in Lincoln County, in the Rezabek and Wilson Valley faunules. It has been found also in the Pleistocene in Nebraska. After more intensive collecting, this species may be found also in the intervening Pleistocene deposits, the Sanborn Formation. *G. contracta* has not been found either in the Pleistocene or the Recent faunules of southwestern Kansas.

Gastrocopta contracta does not appear to have been a predominating representative of the genus in Kansas in Pleistocene times. It was then and is still today, secondary to *G. armifera*.

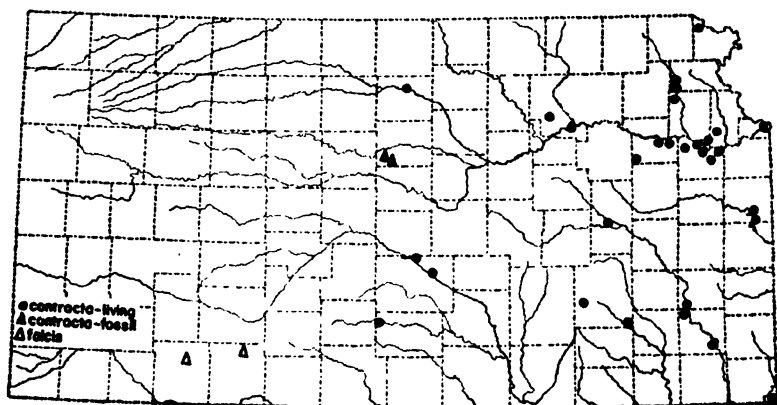


FIG. 4. Records of *Gastrocopta contracta* (Say) and *G. falcis* Leonard.

Gastrocopta falcis Leonard

Plate XVIII, fig. 2. Text figure 4.

Gastrocopta falcis Leonard, 1946, pp. 22-24.

Description of the shell: "Shell small, cylindrical, narrowly perforate; whorls 5 in number, moderately convex; summit obtuse; suture deeply impressed; first whorl microscopically granular, remaining whorls minutely punctate and striate; body whorl compressed around axis, broadly angulate below; aperture rounded below, squarish above; peristome thin, simple and reflected, lips approaching, scarcely connected by a thin callus on body whorl; a constriction behind reflected lip of peristome, followed by a heavy crest on right side only; behind the crest an axially elongate, depressed scar indicates position of lower palatal plica. Lamella 7 in number; angular, thin, high, confluent with angular lip of peri-

stome above, and with parietal lamella below; it curves slightly toward, and is deflected toward, the periphery; parietal lamella heavy, widely divergent from angular above; below the lower end of the angular, where it is strong, high, and rounded, the parietal lamella curves toward the periphery; columellar lamella highly specialized; it arises low in orifice as a high plate extending toward the parietal, turns slightly upward, and extends straight forward on the columellar wall of the peristome to the point where the lip flares, where it ends in a thickened callus; the whole resembling a pruning knife with the thin edge turned toward the columella. No subcolumellar denticle; basal plicae heavy, triangular, deeply placed in the cavity; lower palatal plica arising broadly from the callus on which are set also the basal and upper palatal plicae, deeply entering, to a point above the termination of the angular, free surface plane; upper palatal plica less deeply placed, high toothlike; two minute, conical suprapalatal plicae. Denticles and walls of orifice smooth and glistening." (Leonard, 1946.)

Variations: No significant variation occurs among the 4 shells of the series.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	1.7	0.87	0.62	0.55	5
Paratype:	1.5	0.87	0.62	0.59	5
	1.75	0.87	0.62	0.55	5

Habitat: This species is known only from deposits of the Meade Formation, Middle Pleistocene.

Distribution:

Type locality: Meade County, Kansas: Cudahy Volcanic Ash Pit, SW $\frac{1}{4}$, S 2, T 31 S, R 28 W, 6 mi. N of Meade.

Distribution in Kansas:

Pleistocene: Meade County: Type locality. Clark County: Pyle Ranch, NE $\frac{1}{4}$, S 13, T 30 S, R 23 W, 13 mi. E, $\frac{1}{2}$ mi. S of Minneola.

Gastrocopta holzingeri Sterki

Plate XVIII, fig. 2. Text figure 5.

Pupa holzingeri Sterki, 1889, *Nautilus* iii, p. 119.

Bifidaria holzingeri, Hanna, 1909, p. 94; Over, 1942, p. 8; Hanna and Johnston, 1913, p. 119.

Bifidaria holzingeri fordiana, Hanna, 1909, p. 94.

Gastrocopta holzingeri, Pilsbry, 1916, Vol. 24, pt. 93, pp. 25-26, Pl. 2, figs. 4, 5, 6; Henderson, 1924, pp. 79, 131; Hibbard, 1941, p. 265; Frye and Hibbard, 1941, p. 408; Frye, Leonard, and Hibbard, 1943, p. 42.

Gastrocopta procera cf. *mcclunigi*, Frye, Leonard, and Hibbard, 1943, p. 42; Hibbard, 1943, p. 236.

Description of the shell: Shell small; oval; height 1.6 mm. to 1.9 mm.; grayish-white, translucent, glossy; rimate; whorls 5, convex, gradually and regularly increasing in size; $1\frac{1}{2}$ nuclear whorls minutely granular; remaining whorls very finely and irregularly striate; body whorl less than one-half the total height; aperture irregularly rounded, exceeding one-half the height of the body whorl; lamellae and folds 7, the angular and parietal lamellae fused inwardly and distinct outwardly, the parietal lamella long, high, sinuous, the angular lamella short, the two forming a mirror image of the pattern of the letter "Y"; the 4 folds situated on a heavy palatal callus; a low, tubercular suprapalatal, a prominent tubercular, lower palatal, a higher, slightly elongate lower palatal, the three becoming progressively more deeply immersed; a prominent, slightly elongate basal fold, less deeply immersed than the lower palatal fold; columellar lamella situated midway on the ultimate portion of the columella, high, elongate, entering horizontally and posterior third turned downward; peristome narrowly reflected, terminations approaching and connected across the parietal wall by a thin callus; margin sharp; a high, heavy rounded, white callus situated on the body whorl and separated from the peristome by a wide groove.

Variations: Only a few characters are perceptibly variable. The total height varies from 1.6 mm. to 1.9 mm. The number of whorls varies from $4\frac{1}{2}$ to 5.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.6	0.8	0.5	0.5	$4\frac{1}{2}$
1.7	0.8	0.6	0.5	$4\frac{3}{4}$
1.8	0.9	0.6	0.6	5
1.9	0.9	0.6	0.5	5

Habitat: *Gastrocopta holzingeri* is found on timbered slopes under leaf mold. Although it may occur in large numbers, it is probably overlooked because of its small size.

Fossil records show that *G. holzingeri* has lived in Kansas since at least Blencian times. Hibbard (1941a, pp. 100-101) concludes that, according to geological studies by Frye, in Blencian times a low gradient, mountain fed stream flowed through southwestern Kansas, south to the Gulf. The preserved fauna associated with the gastropod mollusks of this locality indicates that along the valley probably were meadows, marshes, and trees. The summers were

probably characterized by temperatures somewhat lower than they are in the region today, accompanied by higher humidity, and absence of extreme droughts.

In order to remain established in northwestern Kansas, as it is doing to some extent, it must be tolerant of the hot, dry climatic conditions which obtain in the summertime. *G. holzingeri* is not one of the predominating species of the fauna of Kansas. According to its general distribution in North America, it prefers decidedly cooler climates.

Distribution:

Type locality: Winona, Minnesota.

General distribution: Ontario and western New York west to Helena, Montana; south to Illinois, Kansas, and eastern New Mexico (Pilsbry, 1916, Vol. 24, pt. 93, p. 25). Pleistocene of Nebraska.

Distribution in Kansas:

Recent: Wyandotte County west to Cheyenne County; central Kansas, Reno County, probably from drift along the Arkansas River; south-eastern Kansas, Labette County.

Pleistocene: Lincoln County, Rezabek faunule, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln.

Blancan: Meade County, Rexroad faunule, Locality number 3 (Hibbard, 1941, p. 265), 9 mi. S, 7 mi. W of Meade, SW¼, S 22, T 33 S, R 29 W.

According to fossil records, *Gastrocopta holzingeri* has been living in Kansas since Blancan times, although this species is essentially a snail of northern United States.

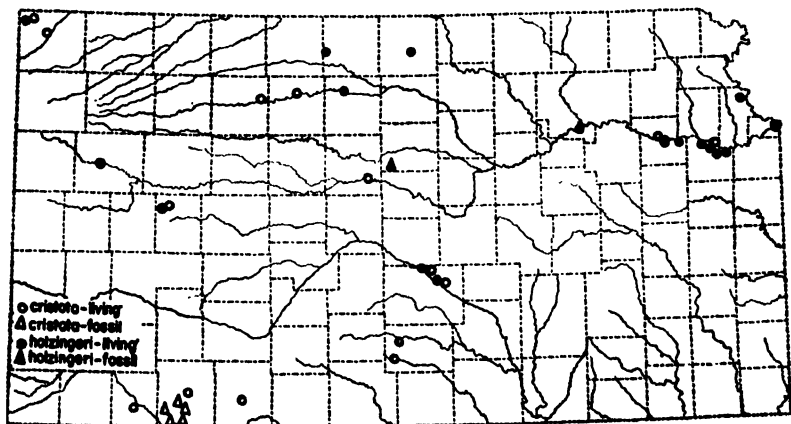


FIG. 5. Records of *Gastrocopta holzingeri* (Sterki) and *G. cristata* (Pilsbry and Vanatta).

Gastrocopta tappaniana (C. B. Adams)

Plate XVIII, fig. 8. Text figure 6.

Pupa tappaniana Ward inedit, C. B. Adams, 1842, p. 158.*Bifidaria pentodon*, Hanna, 1909, p. 94.*Bifidaria tappaniana*, Hanna, 1909, p. 94.*Gastrocopta pentodon*, Franzen and Leonard, 1942, p. 339, Pl. 1, fig. 1; Franzen and Leonard, 1943, p. 417-418, Pl. XXXII, fig. 33, text fig. 6.*Gastrocopta tappaniana*, Pilsbry, 1916, Vol. 24, pt. 93, pp. 33-35, Pl. 3, fig. 9, Pl. 5, figs. 42-53; Lugin, 1935, p. 212, Table C; Hibbard, 1941, p. 265; Franzen and Leonard, 1942, p. 339, Pl. 1, fig. 6; Frye, Leonard and Hibbard, 1943, pp. 41, 42; Hibbard, 1943, p. 236.*Gastrocopta tappaniana curta*, Leonard, 1943, p. 239, Pl. 1, fig. 15.

Description of the shell: Shell conic, summit obtuse, 1.5 mm. to 2.5 mm. in height; grayish-white; translucent; rimate, minutely perforate; whorls $4\frac{1}{2}$ to 5, regularly and rapidly increasing in height; body whorl exceeding $\frac{1}{2}$ of the total height; the $1\frac{1}{2}$ nuclear whorls finely granular, remaining whorls finely and irregularly striate; aperture ovate, oblique, expanding somewhat toward the peristome; folds and lamellae 6 to 9: a low, tubercular infraparietal rarely present; a completely fused, high, lamelliform angulo-parietal situated at the center of the parietal wall; six elongate, equally immersed folds situated on a strong palatal callus, a suprapalatal, an upper palatal, an interpalatal, a lower palatal, an infrapalatal, and a basalar; a lamelliform, elongate, columellar lamella ascending along the axis; peristome simple, scarcely reflected, terminations approaching and connected across the parietal wall by a thin callus, margin sharp; a heavy, white callus on the body whorl paralleling the peristome and separated from it by a narrow groove.

Variations: The shells of *Gastrocopta tappaniana* vary considerably in shape and in size. Shells from any one population can be arranged in a continuous series, ranging from elongate-conic to ovate-conic forms. The total height varies from 1.5 mm. to 2.5 mm. (see table below). The occurrence of certain of the plicae varies: the infraparietal lamella is rarely present; the suprapalatal is sometimes prominent, sometimes scarcely perceptible and sometimes wanting; the basal fold is sometimes double. The variables are phenotypic and not characteristic of the shells of any certain part of the state nor of any one or several fossil faunules. The shells from the Saw Rock Canyon deposits of Upper Pliocene (?) age, do not differ from those living in Kansas at the present time.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.5	0.9	0.4	0.4	4½
1.8	1.1	0.5	0.5	5
2.2	1.35	0.8	0.7	4½
2.5	1.35	0.8	0.7	5

Habitat: *Gastrocopta tappaniana* is a common snail in Kansas. Its most frequent habitat is on shaded slopes near streams. However, it has been taken from among the grass roots on an unshaded slope near a pasture pond.

Distribution:

Type locality: Vermont.

General distribution: Ontario; Maine to Virginia, west to South Dakota and Kansas, to Arizona (Pilsbry, 1916, Vol. 24, pt. 93, p. 33). Pleistocene of Nebraska and Kansas.

Distribution in Kansas:

Recent: Widespread in distribution: along the courses of the Kansas River and its tributaries; Neosho River Arkansas River, Meade County State Park, and South Fork of the Republican River.

Pleistocene: Lincoln County: Rezabek Faunule, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln; Wilson Valley Faunule, S 23, T 13 S, R 10 W, 9 mi. S, 15 mi. W of Lincoln. Clark County: Pyle Ranch Faunule, S 13, T 23 W, 13 mi. W, ½ mi. S of Minneola. Russell County: Tobin Faunule, S 35, T 14 S, R 11 W, 5½ mi. S, 18 E of Russell.

Blancan: Meade County: Fox Canyon Faunule, 17 mi. S, 12 mi. W of Meade, S 35, T 34 S, R 30 W; Big Springs Ranch, NW¼, NW¼, S 19, T 32 S, R 28 W, 2 mi. S, 4 mi. W of Meade.

Gastrocopta tappaniana, essentially a northern species, entered Kansas sometime previous to Upper Pliocene times. Since its entrance into this region, it has become widespread, and it is still one

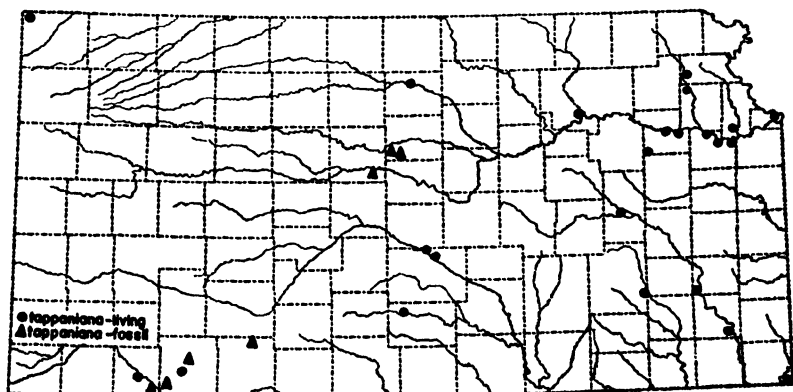


FIG. 6. Records of *Gastrocopta tappaniana* (C. B. Adams).

of the most abundant species of the genus represented in Kansas. Shell characters of this species have remained unchanged since Pliocene times.

Gastrocopta rexroadensis new species

Plate XVIII, figs. 4 & 5. Text figure 7.

Holotype: Catalogue number 3781, University of Kansas Museum of Natural History.

Horizon and type locality: Blancan. Meade County, Kansas, Rexroad Ranch, SW $\frac{1}{4}$, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade.

Diagnosis: Shell small, elongate-conic, rimate; whorls $4\frac{3}{4}$, slightly convex; lamellae and folds 5, large, nearly filling the aperture: a prominent, arched, deeply immersed parietal lamella; an elongate, prominent angular lamella, approximate to but not fused posteriorly with the parietal lamella; upper palatal fold immersed, appearing as a callus of the peristome; a deeply immersed, oblique lower palatal fold; a prominent columellar lamella, entering horizontally and turned downward posteriorly; peristome continuous across parietal wall by means of a thin callus. Subgenus *Immersi-dens*.

Description of the Holotype: Shell small, elongate-conic; summit obtuse; rimate; suture sharply incised; whorls $4\frac{3}{4}$; apical whorls strongly convex, lower whorls slightly convex; whorls slowly and regularly increasing in size; the $1\frac{1}{2}$ nuclear whorls finely granular; remaining whorls irregularly and finely striate; height of body whorl exceeding one-half of the total height, contracted basally and expanding rapidly toward the aperture; a prominent, rounded crest paralleling the peristome from which it is separated by a deep, wide groove; aperture triangularly rounded, scarcely oblique, widely expanding; denticles 5; a prominent, oblique, arched, deeply immersed parietal lamella extending toward the periphery below the angular lamella; an elongate, prominent angular lamella arising from the peristome, approximate to but not fused posteriorly with the parietal lamella; the upper palatal fold immersed, fused with a triangular callus on the outer border of the peristome; a prominent, shortly elongate, deeply immersed, oblique lower palatal fold; a prominent columellar lamella, entering horizontally with the posterior half turned downward; margin of peristome very narrowly reflected; ends of peristome approaching, connected by a thin callus upon the parietal wall.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	2.4	1.35	0.9	0.9	4 $\frac{1}{4}$
Paratype:	2.25	1.25	0.9	0.8	5
Cat. No. 3764.....	2.35	1.35	0.9	0.8	5
Cat. No. 3764.....	2.35	1.25	0.8	0.7	5
Cat. No. 3764.....	2.4	1.25	0.9	0.8	5 $\frac{1}{4}$

The paratypes of *G. rexroadensis* vary slightly in size and form, some shells being more conic than others.

G. rexroadensis is closely related to *G. bilamellata* (Sterki and Clapp), a species known from southwestern Arizona. *G. rexroadensis* is more conic than *G. bilamellata*; the upper palatal fold is fused with a broad, pointed callus on the outer wall of the peristome; and the parietal lamella is straight rather than sinuous.

Occurrences: In addition to the type locality, *Gastrocopta rexroadensis* occurs in two other deposits assigned to the Blencoe age: Meade County; Fox Canyon deposit, S 35, T 34 S, R 30 W, 17 mi. S, 12 mi. W of Meade, Big Springs Ranch deposit, SW $\frac{1}{4}$, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade.

Gastrocopta corticaria (Say)

Plate XVIII, fig. 8. Text figure 7.

Odostomia corticaria Say, Nicholson's American Encyclopedia, IV, Pl. 4, fig. 5, 1816.

Gastrocopta corticaria, Pilsbry, 1916, Vol. 24, pt. 93, pp. 52-53, Pl. 10, figs. 1 to 4; Franzen, 1944, p. 265, Pl. I, fig. 1.

Description of the shell: Shell small, 2.4 mm. to 2.8 mm. in height; ovate, summit obtuse; rimate, minutely perforate; fragile;

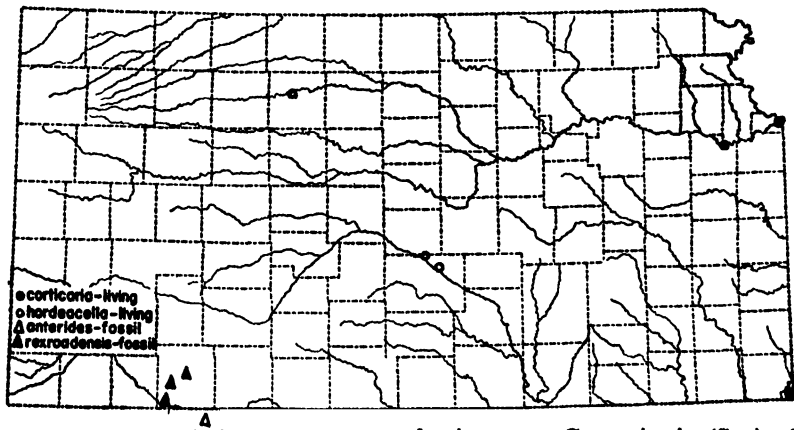


FIG. 7. Records of *Gastrocopta rexroadensis* n. sp., *G. corticaria* (Say), *G. pellucida hordeacella* (Pilsbry) and *G. anterides* Leonard and Franzen.

translucent, grayish-white; suture incised; whorls 5, convex, increasing slowly and regularly in size; body whorl large, somewhat more than $\frac{1}{2}$ total height of shell; nuclear whorl minutely granular; remaining whorls irregularly and finely striate; aperture large, oval, without any callus; lamellae and folds 3; a low, elongate parietal lamella distinct or partially fused with an elongate, low angular lamella; a low tubercular, oblique columellar lamella; a low, tubercular palatal fold rarely present; peristome thin, without a callus, terminations approaching, connected across the parietal wall by a thin callus; peristome reflected, producing a groove on the exterior of the ultimate whorl directly behind the peristome; margin sharp.

Variations: Only 7 specimens from Kansas and 3 from Kansas City, Missouri, were available for study. The total height varied only 0.3 mm. (table of measurements below). The angular lamella, if present, is low, elongate or tubercular; the parietal lamella is low and elongate, or low and tubercular. In one shell from Kansas City, Missouri, a tubercular palatal fold is present.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.4	1.2	1.0	0.8	5
2.5	1.25	1.0	0.8	5
2.7	1.25	0.9	0.8	5½
2.8	1.35	1.1	0.8	5

Habitat: *G. corticaria* has been found along timbered slopes near streams, where oak and hickory predominate.

Distribution:

Type locality: Philadelphia, Pennsylvania.

General distribution: Ontario to Minnesota; Maine, south to St. Simon's Island, Georgia; northern Alabama; Louisiana (Pilsbry, 1916, Vol. 24, pt. 93, p. 53). Western Missouri, Kansas.

Distribution in Kansas:

Recent: Wyandotte County: Kansas City. Douglas County: Lawrence.

Cherokee County: 6 mi. E of Baxter Springs.

This small shell is not known from the Pleistocene. Its Recent distribution may be more widespread than the number of reported localities would indicate. Because of its small size it can easily be overlooked. However, if it is present, it should be found in drift more frequently than it has been. Since it is a species of humid environment, it is restricted to those localities in Kansas where such a condition obtains.

Gastrocopta procera (Gould)

Plate XVIII, figs 3 & 6. Text figure 8.

Pupa procera Gould, 1840, p. 401, Pl. 8, fig. 12.*Bifidaria procera*, Hanna and Johnston, 1909, pp. 81-82; Over, 1942, p. 8.*Bifidaria mcclungi* Hanna and Johnston, 1918, pp. 111-121.*Gastrocopta procera*, Pilsbry, 1916, Vol. 24, pt. 98, pp. 62-65; Lugen, 1935, p. 212, Table C; Goodrich, 1940, pp. 78-79; Hibbard, 1940, p. 418; Frye, Leonard, and Hibbard, 1943, pp. 41, 42; Hibbard, 1943, p. 286.*Gastrocopta procera mcclungi*, Pilsbry, 1916, Vol. 24, pt. 98, pp. 66-68; Henderson, 1924, pp. 79, 132; Franzen and Leonard, 1942, pp. 339, Pl. 1, fig. 7; Franzen and Leonard, 1943, pp. 419, Text fig. 65, Pl. XXXII, fig. 32; Leonard, 1943, pp. 239, Pl. 1, fig. 14; Leonard and Leonard, 1946, p. 120.*Bifidaria procera mcclungi*, Over, 1942, p. 8.*Gastrocopta procera duplicata*, Franzen and Leonard, 1942, pp. 339, Pl. 1, fig. 8; Franzen and Leonard, 1943, p. 419, Text fig. 6, Pl. XXXII, fig. 31.*Gastrocopta procera sterkiana*, Leonard and Leonard, 1946, p. 120.

Description of the shell: Shell auburn to light brown; glossy; rimate; cylindric; apex obtuse; moderate in size for the genus; suture deeply incised; whorls 5 to $6\frac{1}{2}$, finely and irregularly striate, convex, gradually and regularly increasing in size; body whorl about one-half the height of the shell, somewhat constricted at the base and gradually expanding toward the aperture, linear impressions mark the positions of the upper palatal, the lower palatal, and the basal folds; a crest parallels and is approximate to the peristome; aperture rounded, slightly oblique, a deep sinulus at upper extremity of outer lip; peristome slightly reflected and thin to broadly reflected and thickened by a heavy callus; folds and lamellae 6: a bifid angulo-parietal, the angular portion forming a spur directed toward the outer margin; an immersed, tubercular upper palatal fold; an elongate, deeply immersed, obliquely placed lower palatal fold; a low basal fold immersed equidistant with the upper palatal fold; columellar lamella horizontal, nearly one-half the length of a whorl; a low tubercular subcolumellar lamella.

Variations: The callus of the peristome varies as to position. In some shells it is located within the aperture below the lip, in some along the inner, and in others, along the outer border of the lip. Shells of *G. procera* from the Saw Rock Canyon deposits, Upper Pliocene (?), Seward County, S 35, T 34 S, R 31 W, 14 mi. E of Liberal, have a tubercular labial callus on the outer lip at the level of the upper palatal fold, Plate IV, fig. 6. The distance between the peristome and the crest paralleling it, varies. The crest of some shells is well-developed and rounded, in some it is low and narrow, in others it is scarcely perceptible. The subcolumellar lamella is usually present as a distinct denticle, however, sometimes it is seen

only as a thickening of the base of the columellar lamella. The range in size of the shells can be seen in the table below.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.1	1.0	0.7	0.7	5
2.3	1.1	0.9	0.7	5½
2.5	1	0.8	0.7	5½
2.8	1.2	0.9	0.9	5½
3.2	1.3	1.1	1	6
3.2	1.2	...	...	6½

Habitat: This pupillid lives on timbered slopes of streams. Its general distribution in Kansas indicates an ability to withstand periods of summer drought. Occurrence with *Gastrocopta cristata* Pilsbry and Vanatta is common.

Distribution:

Type locality: Baltimore, Maryland.

General distribution: Eastern United States, west to Kansas, Oklahoma, Colorado, New Mexico, Arizona; north, South Dakota; south, Alabama and eastern Texas. (Pilsbry, 1916, Vol. 24, pt. 93, p. 63.) Pleistocene, Nebraska.

Distribution in Kansas:

Recent: Along the Kansas River and its tributaries from Kansas City, Wyandotte County, west to Norton and Graham counties; northwest to Cheyenne County; southeastern Kansas: Neosha, Allen, and Greenwood counties; along the Arkansas River and its tributaries. Southwestern Kansas: Meade County; Seward County, along the Cimarron River.

Pleistocene: Lincoln County: Wilson Valley Faunule, NE¼, S 28, T 13 S, 9 mi. S, 15 mi. W of Lincoln; Rezabek Faunule, NE¼, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln. Russell County: Tobin Faunule, NW¼, S 27, T 14 S, R 11 W, 4½ mi. S, 17 mi. E of Russell. Meade County: Jones Sink Faunule, S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E of Meade, locality number 13 (Hibbard, 1940, p. 417).

Sanborn Formation: Norton County, NE¼, S 21, T 5 S, R 23 W, 15 mi. S, 1¼ mi. W of Norton. Phillips County: Prairie Dog Creek.

Upper Pliocene (?): Seward County, Saw Rock Canyon, S 35, T 34 S, R 31 W, 14 mi. E of Liberal.

Pupillids which have been referred to *Gastrocopta procera* and to the two "subspecies," *G. p. mcclungi* and *G. p. sterkiiana*, have been collected from Kansas. According to the type descriptions of these forms, they differ from each other in the location and thickness of the palatal callus. In *G. procera*, the callus is along the inner margin of the peristome; in *G. p. mcclungi*, the callus is said to be heavier and situated along the outer margin of the peristome; *G. p. sterkiiana*

differs from the above two forms by the callus being lower and farther within the aperture.

Gastrocopta procera and the two "subspecies" under consideration, have been collected in Kansas at various localities which differ in environmental conditions. The authors found that in a majority of the localities in Kansas from which *G. procera* was obtained, either one or both of the above two "subspecies" occurred. Furthermore, the characters of the shell which are used to differentiate these forms intergrade among the Recent as well as among fossil individuals in lots taken from the same locality. Shells from the same locality cannot be successfully separated into the three categories. This intergradation of the three forms within a population occurs throughout Kansas as well as in the neighboring states of Arkansas, Oklahoma, and Texas. The occurrence of typical *G. procera*, *G. p. mcclungi*, and *G. p. sterkiana* is not limited geographically, nor can the position of the callus be correlated with any climatic conditions nor with any other variables of the shell.

Since the characters used in separating the three forms intergrade among individuals of the same population and this intergradation is widespread geographically, and since no two subspecies occupy the same geographic locality except in a restricted zone in which they intergrade, *G. p. mcclungi* and the shells from Kansas localities previously identified as *G. p. sterkiana* cannot be considered as subspecies of *G. procera*, but as variations within the species.

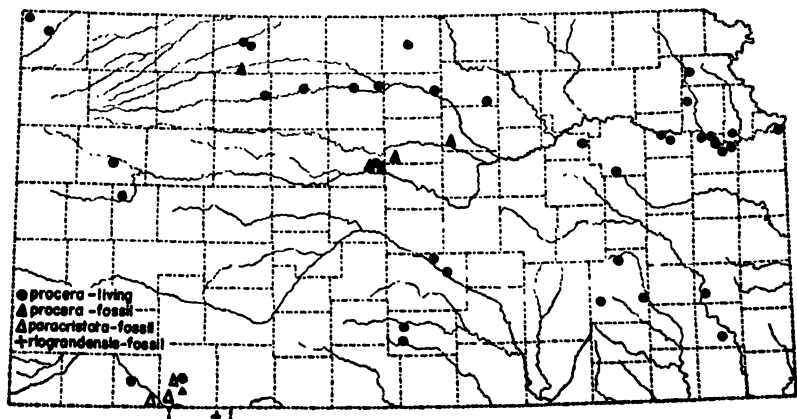


FIG. 8. Records of *Gastrocopta procera* (Gould), *G. paracristata* n. sp., and *G. riograndensis* Sterki.

After studying the shell designated as the holotype of *G. p. mcclungi* in the United States National Museum, and comparing shells identified as *G. p. mcclungi* with *G. procera* at the Philadelphia Academy of Science, and comparing them with shells from Kansas, the authors consider *G. p. mcclungi* as synonymous with *G. procera*. However, not having studied shells of *G. p. sterkiana* from various localities within its range, the author refers the shells from Kansas previously reported as *G. p. sterkiana* to *procera*, without pronouncing judgment on the validity of *sterkiana* as a subspecies.

Gastrocopta cristata (Pilsbry and Vanatta)

Plate XIX, fig. 1, Plate VI, fig. Text figure 5.

Bifidaria procera cristata Pilsbry and Vanatta, 1900, p. 595, Pl. 22, figs. 4, 5; Hanna, 1909, p. 94; Hanna and Johnston, 1913, p. 113.

Gastrocopta cristata, Pilsbry, 1916, Vol. 24, pt. 93, pp. 68-69, Pl. 13, figs. 6, 8 to 12; Baker, 1938, p. 130; Frye and Hibbard, 1941, pp. 390-424; Hibbard, 1941, p. 265; Leonard, 1943, p. 239, Pl. I, figs. 9, 10.

Description of the shell: Auburn to golden brown in color; glossy; surface marked with fine and irregular striations; rimate; cylindrical; apex convex, obtuse; whorls $5\frac{1}{4}$ to $6\frac{1}{2}$, increasing regularly and gradually in size; body whorl more than one-half of the total height, constricted at the base and expanding toward the aperture, linear impressions mark the positions of the upper and lower palatal and basal folds; a prominent, rounded crest parallels the peristome from which it is slightly removed; aperture rounded, slightly oblique, peristome expanding, terminations approaching, connected across the parietal wall by a thin callus; margin slightly reflected, sharp; folds and lamellae six: angulo-parietal fused, sinuous, increasing in height inwardly and terminating abruptly, from without the approach to these lamellae is sometimes "Y"-shaped; upper palatal fold immersed, tubercular; lower palatal fold somewhat more deeply immersed, elongate, and slightly deflected toward the columella; basal fold immersed equidistant with the upper palatal fold; columellar lamella horizontal, elongate, about one-half the length of a whorl; subcolumellar lamella nodose, situated immediately below the columellar lamella.

Variations: The angulo-parietal lamella varies in the degree of sinuosity, sometimes being nearly straight. The crest behind the peristome, usually prominent, is sometimes low; the crest, usually removed from the peristome, is sometimes approximate to it. The lip, typically thin, is infrequently slightly thickened. The aperture varies in size. The size of the shell varies considerably as may be seen in the table below.

Gastrocopta cristata, though closely related to *G. procera*, can, with rare exceptions, be separated from the latter by the completely fused rather than bifid angulo-parietal lamella; the crest behind the lip is usually more prominent and farther removed, and the diameter of the shell is greater. Rarely some shells are very narrow and elongate.

Shells recovered from the several Pleistocene deposits are typical *G. cristata* in their shape and other features. Some of the shells, catalogue number 3771, recovered from a deposit of Blancan age, Rexroad Ranch, Meade County, show a close relationship to *G. procera* by having a semifused angulo-parietal lamella and a prominent, rounded callus on the outer lip. This is considered to be a representation of an isolated population which has retained some of the primitive characteristics. The separation of the ancestral stock into these two species must have occurred at an earlier time since shells from the Fox Canyon fauna, Blancan in age, are typically *G. cristata*.

Although occasional individuals of *G. cristata* closely resemble *G. procera*, these two species do not intergrade. Since these two species are closely related, occasional interbreeding may occur which possibly accounts for an occasional elongate, narrow shell approaching that of *G. procera*.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Pleistocene	3.5	1.4	1.2	1.0	6
Pleistocene	3.5	1.35	1.1	1.0	6½
Recent	3.2	1.35	1.1	...	5½
	3.15	1.35	1.0	1.0	6
	2.7	1.25	1.0	0.9	6
	2.35	1	0.8	0.7	5½

Habitat: *Gastrocopta cristata* has, in Kansas, usually been found associated with *G. procera* (Gould) on timbered slopes near streams. In Meade County it was found living in grassy meadowlands of the State Park (Leonard, 1943, p. 239).

Distribution:

Type locality: Camp Verde, Yavapai County, Arizona.

General distribution in North America: Northern Kansas, south to Oklahoma and southern Texas; west to New Mexico and Arizona (Pilsbry, 1916, Vol. 24, pt. 93, p. 68).

Distribution in Kansas:

Recent: Along the Kansas River and its tributaries, Douglas and Shaw-

nee counties west to Rooks, Graham and Logan counties; northwest to Cheyenne County; south to Reno, Kingman, Clark, Meade, and Seward counties.

Pleistocene: Meade County: Jones Sink, Locality number 13 (Hibbard, 1940, p. 417), S 8, T 33 S, R 27 W, 5 mi. S, $3\frac{1}{2}$ mi. E of Meade; XI Ranch, high terrace, S 33, T 34 S, R 29 W, 15 mi. S, 7 mi. W of Meade. Blancan: Meade County: Rexroad Ranch, SW $\frac{1}{4}$, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade; Big Springs Ranch, NW $\frac{1}{4}$, NW $\frac{1}{4}$, S 19, T 32 S, R 28 W, 2 mi. S, 4 mi. W of Meade; Fox Canyon, S 35, T 34 S, R 30 W, 17 mi. S, 12 mi. W of Meade.

Gastrocopta paracristata new species

Plate XIX, figs. 2 & 3. Text figure 8.

Holotype: Catalogue number 3929, University of Kansas Museum of Natural History.

Horizon and type locality: Blancan, Fox Canyon, Meade County, Kansas, S 35, T 34 S, R 30 W, 17 mi. S, 12 mi. W of Meade.

Diagnosis: Shell moderate in size for the genus; elongate oval; rimate, minutely perforate; whorls $5\frac{3}{4}$, convex; lamellae and folds 5: a fused, sinuous, angulo-parietal, the angular portion continuous with the parietal callus and the outer lip; 3 equally immersed palatal folds connected anteriorly to the palatal callus; a horizontal columellar fold, the extreme innermost portion ascending the columella. Subgenus *Gastrocopta*.

Description of the Holotype: Shell elongate-oval, summit obtuse; rimate, minutely perforate; suture sharply and deeply incised; whorls $5\frac{3}{4}$; convex, regularly and slowly increasing in size; the $1\frac{1}{2}$ nuclear whorls finely granular; remaining whorls finely and irregularly striate; height of body whorl less than one-half of the total height of the shell, constricted at the base and expanding rapidly toward the aperture; prominent, rounded crest paralleling the peristome from which it is somewhat removed; aperture rounded, slightly oblique, expanding toward the peristome; denticles 5: a fused, sinuous, angulo-parietal, the angular portion continuous with a parietal callus and outer lip; 3 equally entering palatal folds, connected anteriorly by a low callus, a tubercular upper palatal, a higher, elongate lower palatal, its highest point about midway of its length, and a low, tubercular basal fold; the columella lamella high, elongate, entering horizontally and ascending the spire at its extreme innermost portion; peristome reflected, thickened along its inner border, margin sharp.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	3.1	1.35	1.	1.0	5 $\frac{1}{2}$
Paratype:	3.4	1.4	1.	1.1	6 $\frac{1}{2}$
Paratype:	3.3	1.4	1.	1	6 $\frac{1}{4}$
Paratype:	2.9	1.3	1.	0.9	5 $\frac{1}{4}$
Paratype:	2.7	1.5	1.	1.0	5 $\frac{1}{4}$

The range in height of the shells of *Gastrocopta paracristata* is from 2.7 mm. to 3.4 mm. The width varies independently of the height, therefore, shells vary in shape from elongate-ovate to elongate-conic. The basal fold, usually prominent, is sometimes very low and occasionally wanting. The callus of the peristome varies in prominence. A prominent, rounded crest on the ultimate whorl, paralleling the peristome is usually present, rarely wanting, sometimes low and sharp. The distance between the peristome and the center of the crest varies from 0.5 to 0.25 mm. Two sinistral individuals occur in the Rexroad faunule.

Gastrocopta paracristata differs in several respects from *Gastrocopta cristata* to which it is closely related. *G. paracristata* lacks the subcolumellar lamella which is present in *G. cristata*. The anterior portion of the lower palatal fold of *G. paracristata* is in contact with the palatal callus, whereas, in *G. cristata* the lower palatal fold is removed from the callus. The peristome is usually heavier in *G. paracristata* than it is in *G. cristata*.

Occurrences: *Gastrocopta paracristata* is known from three localities: Blancan: Type locality, Fox Canyon, Meade County, S 35, T 34 S, R 30 W, 17 mi. S, 12 mi. W of Meade; Rexroad Ranch, Meade County, SW $\frac{1}{4}$, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade. Upper Pliocene (?): Saw Rock Canyon, Seward County, S 35, T 34 S, R 31 W, 14 mi. E of Liberal.

Gastrocopta riograndensis (Sterki)

Plate XIX, fig. 7. Text figure 8.

Pupa riograndensis Sterki, 1891, p. 142.

Gastrocopta riograndensis, Pilabry, 1916, Vol. 24, pt. 93, pp. 69-70; Leonard and Franzen, 1944, p. 80, Pl. V, fig. 14.

Description of the shell: Shell elongate ovate, summit convex; suture deeply incised; whorls 5, convex, gradually and regularly increasing in size; 1 $\frac{1}{2}$ nuclear whorls finely granular, remaining whorls irregularly and finely striate; body whorl large, exceeding one-half the height of the shell; aperture large, exceeding one-half

the height of the body whorl, irregularly rounded; a fused, anteriorly bifid, angulo-parietal lamella situated at the midpoint of the parietal wall, the angular portion forming a spur directed toward the outer lip; the outer portion continuous with the upper lip; three deeply immersed palatal folds, a shortly elongate upper palatal, a high, elongate lower palatal, and a tubercular basalar; columellar lamella horizontal, prominent, elongate, extending about one-half the length of a whorl, thickened at the base; peristome broadly reflected, thin at the margin, thickened by a callus along the inner border; a callus prominence on the inner border of the outer lip results in a sinus at the upper right-hand portion of the aperture, the inner border of which is continuous with the angular lamella; a prominent, narrow callus on the body whorl parallels the peristome from which it is separated by a groove; body whorl indented behind the crest; a longitudinal impression at the level of the lower palatal fold.

Variations: The shells vary in size and general form. Some are narrow and elongate, some tend to be conically-elongate. In some instances the base of the columella is thickened almost to the extent of forming a subcolumella lamella, in others the base of the columella is only slightly thickened. The width of the peristome and the size of the callus along its inner margin vary. In some shells the crest behind the peristome is sharp and very prominent, whereas in others it is almost wanting. The infraparietal is wanting in all of the 9 shells of the one series in the collection of the University of Kansas.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.5	1.2	0.9	0.8	5¼
2.5	1.25	0.9	0.8	5¼
2.6	1.2	0.9	0.8	5¼
2.7	1.2	0.9	0.8	5½

Habitat: Chaney and Elias (1938, pp. 25-34) interpreted, on the basis of the fossil flora, the climatic conditions which characterized Beaver County, Oklahoma, at the time the Laverne deposits were laid down. The flora found in these deposits suggests that a flood plain forest existed in Beaver County in Lower Pliocene times. This forest was similar to the one growing today in eastern and central Oklahoma. The present annual precipitation in eastern Oklahoma is more than 30 inches, which may have been approximately the amount in Beaver County in Lower Pliocene times. The temperature was probably somewhat warmer than present day tem-

peratures of western Oklahoma. It is probable that *Gastrocopta riograndensis*, associated with other pupillids such as *G. anterides* Leonard and Franzen, and *Pupoides marginatus* Say, was a woodland snail.

Distribution:

Type locality: Hidalgo, Texas.

General distribution: Texas; Lower Rio Grande Valley. Mexico, Panuco River Valley, Tampico, Tamaulipas, below Valles and Las Canoas, San Luis Potosi (Pilsbry, 1916, Vol. 24, pt. 93, p. 70). Laverne Formation, Beaver County, Oklahoma, Pliocene (Leonard and Franzen, 1944, pp. 17, 30).

Gastrocopta pellucida hordeacella (Pilsbry)

Plate XIX, fig. 8. Text figure 7.

Pupa hordeacella Pilsbry, 1890, p. 44, Pl. 1, figs. g, h, i, j, k.

Bifidaria hordeacella, Hanna, 1909, p. 94.

Gastrocopta pellucida hordeacella, Pilsbry, 1916, Vol. 24, pt. 93, pp. 78-80, Pl. 17, figs. 1-4, Pl. 16; Henderson, 1924, pp. 79, 132.

Description of the shell: Shell small, elongate and narrow, sub-cylindrical; height varying from 1.9 mm to 2.5 mm.; light brown in color, pellucid; rimate; suture sharply and deeply incised; whorls 5 to 5½, convex, increasing gradually and regularly in size; 1½ nuclear whorls finely granular; remaining whorls finely and irregularly striate; body whorl slightly more than half total height of shell; aperture oval, slightly oblique, without a callus; lamellae and folds 5: an elongate, prominent, sinuous angulo-parietal lamella frequently with a spur on the columellar side, angular portion continuous with the outer lip, a tubercular upper palatal fold, a prominent, elongate, somewhat more deeply immersed lower palatal fold, a prominent, tubercular basal fold, a prominent, elongate, horizontal columellar lamella, base thickened; peristome simple, reflected, forming a groove on the ultimate whorl immediately behind the peristome; terminations approaching and continuous across the parietal wall by a thin callus; margin sharp.

Variations: The only variants evident in the small series in our collections are the variation in size and in the number of whorls as shown in the table below.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.9	0.8	0.6	0.6	5
2.2	0.9	0.8	0.7	5
2.4	1.0	0.8	0.7	5½
2.5	1.0	0.8	0.7	5½

Habitat: The single shell taken from the locality in Rooks County designated below, was found in local debris on the shore of the Rooks County State Lake. The drift was apparently composed of debris washed down from the immediate slope which was covered with short grass and a few dwarfed trees. The other Kansas shells of this species are probably from drift of the Arkansas River, therefore, the geographic origin of those shells is not known.

Distribution:

Type locality: New Braunfels, Texas.

General distribution: Florida and the Keys north to New Jersey; north-eastern Oklahoma west to southeastern Colorado, and Arizona; Lower California (Pilsbry, 1916, Vol. 24, pt. 93, p. 79).

Distribution in Kansas:

Recent: Rooks County; SW $\frac{1}{4}$, S 34, T 7 S, R 18 W, 2 mi. S, 2 mi. W of Stockton. Reno County: Hutchinson, Nickerson.

Gastrocopta pellucida hordeacella, essentially a southern snail, has been found only in small numbers in Kansas. This species is not known in Kansas from any fossil beds. Apparently its entrance into territory of the midwest as far north as Kansas has been made possible by the change from a cool, humid, glacial climate to the warmer, drier climate of postglacial times.

Gastrocopta anterides Leonard and Franzen

Plate XIX, fig. 9. Text figure 7.

Gastrocopta anterides Leonard and Franzen, 1944, pp. 29-30.

Description of the shell: "Shell small, perforate, conic-ovate in form; whorls 5, moderately convex, increasing regularly in size, except the last which is compressed around the axis; suture sharply incised, but not deep; aperture obliquely oblong; peristome thin, sharp, margins approaching and connected across parietal wall by thin callus; the one and one-half nuclear whorls nonstriated, granular; remaining whorls marked with fine, closely spaced, oblique striations; denticles 5: the angular projecting as a small spur from the well fused angulo-parietal, the tooth extending from the inner margin of the angular lip of the peristome to a point opposite the columellar lamella, terminating in a strong pyramidal buttress; columellar lamella well developed, horizontally compressed around the axis, its inner termination turned downward; basal fold feebly developed; lower palatal dentiform, somewhat laterally compressed, diminishing as it extends inward; upper palatal fold nodose, weakly developed; palatal folds set on a callus which bears faint suggestions

of two interpalatal plicae; the callus appears also as a low external ridge." (Leonard and Franzen, 1944, pp. 29-30).

Variations: "The two paratypes of *Gastrocopta anterides*, except for a few slight variations in the development of the denticles, are identical with the type. The angulo-parietal and the columellar lamellae are invariable, but in the one specimen the basal fold is feebly developed, as in the type, in the other nodose. The interpalatal folds are missing in one example, although the callus between the upper and lower palatals is persistent; in this specimen there is an indentation of the angular portion of the peristome suggestive of the angle so characteristic of *Vertigo*." (ibid, p. 30).

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	2.9	1.9	1.08	0.99	5

Habitat: Probably a woodland pupillid which lived in association with *Pupoides marginatus* and *Gastrocopta riograndensis*.

Distribution:

Type locality: Laverne Formation. Lower Pliocene, 6½ mi. S, ½ mi. W of Gate, Beaver County, Oklahoma.

General distribution: Known only from the type locality.

Genus *Vertigo* Müller

Vertigo O. F. Müller, 1774, p. 124.

"*Isthmia* Gray, London Medical Repository, xv, 1821, p. 239, for ' "*Helix Isthmia cylindrica* Draparnaud t. 3, f. 80, 81" ' = *V. pygmaea* Draparnaud cf. Dall, Tr. Wagner Inst. iii, pt. 2, p. 248; *Nautilus* xvii, 1904, p. 114, and Newton and Harris, Proc. Malac. Soc. London i, p. 72, footnote 1.—Gray, P. Z. S. 1847, p. 176, type *Vert. nitida* = *edentula* Draparnaud.

Alaea Jeffreys, Trans. Linn. Soc. London xvi, 1880, p. 357. Gray, P. Z. S. 1847, p. 176, type *A. palustris* Jeffreys = *V. antivertigo*.—Pilsbry, *Nautilus* xviii, 1905, p. 119.

Staurodon Lowe, Proc. Zool. Soc. 1854, p. 214, type *P. pygmaea* Draparnaud. Not *Staurodon* Lowe, 1852.

Deziogyra Stabile, Moll. terr. Viv du Piemont, 1864, p. 104 (in Atti della Soc. di Scienze Nat. Milano, vi), for *V. moulinsiana*, *V. pygmaea*, *V. antivertigo*, *V. antivertigo* here designated as type.

Deziogira De Betta, Moll. Prov. Veron., 1870, p. 83.

Nearctula Sterki, *Nautilus* vi, 1892, p. 5, type by orig. des., *V. californica* Rowell.

Haplopupa Pilsbry, *Nautilus* xi, Feb. 1908, p. 119, monotype *V. dalliana*.

Pupa Draparnaud, 1801, and of many subsequent authors. Not *Pupa* Bolten, . . ." (Pilsbry, 1919, Vol. 25, pt. 98, pp. 69-70.)

Vertigo, Pilsbry, 1919-1920, Vol. 25, pts. 98, 99, pp. 69-221, Plates 6-18. Pilsbry, 1931, and 1934, Vol. 28, pts. 110, 111, pp. 93-105; 1935, Vol. 28, pt. 112, pp. 203-209, Pl. 15, figs. 1, 2, 8, 9; Pl. 18, figs. 11-17; Pl. 22, figs. 7-14, Pl. 24, figs. 1-4, 7-9; Pl. 31, figs. 4, 5.

Characteristics of the shell: Shell moderate to small in size for the family; conically ovate to oval or oblong; summit conic to obtuse; rimate to minutely perforate; total height 1.53 mm. to 2.5 mm.;

whorls $4\frac{1}{2}$ to 5, convex, irregularly and finely to coarsely striate; lamellae and folds 3-9, never concrescent, angular lamella frequently wanting, palatal folds frequently on a palatal callus; frequently a crest on body whorl paralleling the peristome; linear impression frequently present on body whorl at level of upper and lower palatal folds.

Distribution:

Recent: Circumpolar. In North America, abundant in northern latitudes above 60° , in the Canadian and Transition Life zones to about 33° latitude, and south to Arizona at high elevations where cool and humid atmospheric conditions obtain. Five species are known from Mexico and the West Indies. In the Palearctic the genus has undergone the greatest development in Scandinavia and the eastern Alps. Known also from Asia, northern Africa, Japan, and West Indies (Pilsbry, 1919, Vol. 25, pt. 98, pp. 72, 74).

Pleistocene: North America, northern Europe.

Pliocene: southern France.

Miocene: central Europe.

Middle and Upper Oligocene: central Europe.

Lower Oligocene: Baltic coast.

Eocene: western Europe. (Pilsbry, 1919, Vol. 25, pt. 99, pp. 214-215).

KEY TO SPECIES

1. Columellar lamella ascending inwardly..... 2
Columellar lamella not ascending inwardly..... 7
2. Palatal folds on a callus..... 3
Palatal folds not on a callus..... 6
3. Denticles 3-4; a single, short parietal lamella..... *V. tridentata*
Denticles 5 or more..... 4
4. Denticles 5..... *V. elatior*
Denticles 7-9; 3 parietal lamellae..... 5
5. Ultimate whorl exceeding $\frac{1}{2}$ of total height..... *V. ovata*
Ultimate whorl less than $\frac{1}{2}$ of total height..... *V. morsei*
6. Denticles 4-6; a single, lamelliform parietal lamella; lower palatal fold not oblique, not entering deeply..... *V. gouldii*
Denticles 4-5, lower palatal fold oblique, entering deeply..... *V. g. paradoxa*
7. Columellar lamella horizontal. Palatal folds not on a callus..... 8
Columellar lamella crescentic, descending inwardly; palatal folds on a callus..... 9
8. Denticles 6; two parietal lamellae..... *V. hannai*
Denticles 3-4; only 1 parietal lamella..... *V. modesta*
9. Denticles 5; lower palatal fold recurved toward the columella..... *V. milium*
Denticles 7; lower palatal fold not recurved..... *V. hibbard*

Vertigo morsei Sterki

Plate XIX, fig. 4. Text figure 11.

Vertigo morsei Sterki, 1894, pp. 89-90; Walker, 1894, p. 17; Walker, 1899, p. 18; Blatchley and Daniels, 27th Ann. Rep. Dep. Geol. and Nat. Res. Indiana, 1902, pp. 587, 682; Walker, 1906, p. 516, fig. 149; Pilsbry, 1919, Vol. 25, pt. 98, pp. 81-82, Pl. 6, figs. 8, 9.

Description of the shell: Shell largest of the genus represented in the Kansas fauna; elongate-conic, height 2.5 mm.; rimate; suture

sharply and deeply incised; whorls 5 to $5\frac{3}{4}$, convex and inflated, finely and irregularly striate, slowly and regularly increasing in size; body whorl less than half the total height of the shell, contracted at the base and expanding rapidly toward the aperture; crest paralleling the peristome rounded, low and removed from the peristome; body whorl indented immediately behind the crest, linear impressions at the level of the indentation of the aperture and at the upper and lower palatal folds; aperture small, rounded, strongly biarcuate, slightly oblique, dilating rapidly toward the peristome; denticles essentially as in *Vertigo ovata*: a low tubercular infraparietal lamella, an elongate, lamelliform parietal lamella, a low, tubercular angular lamella, a low tubercular suprapalatal fold situated above the indenture of the aperture, a high, angular, elongate upper palatal fold situated at the level of the indenture of the aperture, a high, elongate lower palatal fold, a low tubercular infrapalatal fold, a prominent basal fold and a prominent columellar lamella ascending inwardly; folds on a palatal callus and immersed subequally; peristome narrowly reflected, thin, margin sharp, terminations approaching, continuous across the parietal wall by a thin callus.

Vertigo morsei differs from *Vertigo ovata* in being of greater height, having 6 whorls and in the whorls increasing slowly in size. The latter results in a smaller body whorl and aperture. The columellar lamella is more prominent than it is in *Vertigo ovata*.

Four of a series of 11 shells from the Cudahy faunule, Lower Pleistocene, Meade Formation, 6 mi. N of Meade, cannot be distinguished from *V. morsei*. Seven of this series are transitional in form between *V. ovata* and *V. morsei*. Transitional shells occur in other Pleistocene faunules, Sunbrite (Cudahy) S 26, T 32 S, R 28 W, 3 mi. S of Meade. Upper Pleistocene; Rezabek, Lincoln County, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln. These transitional shells (Plate V. fig. 5), are elongate, about 2.5 mm. in height, have $5\frac{1}{2}$ whorls, a smaller body whorl and aperture than *V. ovata*.

Individuals with characters intergrading between *V. ovata* and *V. morsei* occur also in the Recent fauna, and have been found at the following localities: Kansas City, Wyandotte County; Hutchinson and Nickerson, Reno County; Kingman County; Arkalon, Seward County.

The persistent occurrence of shells transitional between *V. ovata* and *V. morsei* places the validity of *V. morsei* in question. However, since typical *V. morsei* occurs in a single Pleistocene population,

sufficient grounds for reducing the taxonomic status of *V. morsei* are lacking.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
	2.45	1.35	0.8	0.8	5½
	2.45	1.35	0.8	0.8	5½
Transitional Pleistocene ..	2.4	1.4	0.8	0.9	5
Transitional Pleistocene ..	2.5	1.5	0.9	0.8	5½
Recent	2.4	1.5	0.9	0.9	5
Recent	2.3	1.35	0.9	0.8	5
Recent	2.5	1.5	1	0.9	5½

Habitat: "Its habitat appears to be most often near the shore of lakes" (Baker, 1939, p. 104). Since the only shells of *V. morsei* known in Kansas are fossil, its preferred habitat in Pleistocene times here is not known. Though this form is now extinct in Kansas, its general distribution is in areas of a more humid and somewhat cooler climate.

Distribution:

Type locality: Michigan, Kent County.

General distribution: New Jersey, Michigan, Ohio, Indiana, Illinois (Pilsbry, 1919, Vol. 25, pt. 98, p. 81). Pleistocene in Kansas.

Distribution in Kansas:

Pleistocene: Cudahy Volcanic Ash Pit, S 2, T 31 S, R 28 W, 6 mi. N of Meade.

Vertigo ovata Say

Plate XIX, fig. 6. Text figure 9.

Vertigo ovata Say, 1822, p. 375; Hanna, 1909, p. 95; Pilsbry, 1919, Vol. 25, pt. 98, pp. 82-86, 372; Henderson, 1924, pp. 80, 186, fig. 39; Lugin, 1935, p. 212, Table C; Baker, 1938, p. 130; Goodrich, 1940, p. 77; Goodrich in Hibbard, 1940, p. 418; Over, 1942, p. 9; Fransen and Leonard, 1942, p. 339, Pl. I, fig. 3; Fransen and Leonard, 1943, p. 420, text fig. 6, Pl. XXXII, fig. 28; Leonard, 1943, p. 239, Pl. I, fig. 13; Leonard and Fransen, 1944, p. 30, Pl. V, fig. 13.

Vertigo huobardi, Frye, Leonard and Hibbard, 1943, p. 42; Hibbard, 1943, p. 236.

Description of the shell: Shell moderate to large in size for the genus; roundly ovate to elongate; auburn to brown in color; glossy; translucent; rimate; whorls usually 5 in number, the nuclear whorl finely granular; remaining whorls finely and irregularly striate; convex, rapidly increasing in size; body whorl as much as ¾ of the total height of the shell, contracted at the base and rapidly expanding toward the aperture; crest paralleling the peristome, prominent, rounded and removed; linear impressions at the level of the upper and lower palatal folds, sometimes incising the crest; shell indented immediately below the crest; aperture large, slightly oblique, strongly biarcuate, expanding toward the peristome; denticles 9: 3 lamellae on the parietal wall, a low, tubercular infraparietal; a

high, elongate thin parietal lamella, slightly less deeply immersed; a low tubercular angular, slightly less deeply immersed; 5 folds situated on a palatal callus and equidistantly immersed; a low, tubercular suprapalatal just above the indenture of the outer margin of the aperture; an elongate upper palatal increasing in height rapidly and decreasing inwardly slowly; a similar lower palatal; a low, tubercular, infrapalatal; a low, slightly elongate basal; columellar lamella high, elongate, ascending inwardly along the axis; peristome narrowly reflected, thin, margin sharp, continued across parietal wall by a thin callus.

Variations: The variation in shape is pronounced. Shells of several series, one from the Laverne Formation, Lower Pliocene, Beaver County, Oklahoma (Leonard and Franzen, 1944, p. 30), another from the XI Ranch, Pleistocene, Meade County, and one from the Pyle Ranch, Pleistocene, Clark County, are of a typical ovate form. In other series of Pleistocene age as, for example, the Rezabek faunule, Lincoln County, the Cudahy faunule, and Sunbrite (Cudahy) faunule, Meade County, and of Recent age, the shells vary from an ovate to an elongate oval form approaching *Vertigo morsei* Sterki, in size, height of body whorl relative to total height, and the number of whorls.

The whorls, usually 5 in number, vary from $4\frac{1}{2}$ to $5\frac{1}{2}$. The total height varies from 1.8 mm. to 2.7 mm. Not all of the denticles are constantly present. The infraparietal lamella, variable in size, is frequently wanting. The suprapalatal fold varies in degree of prominence, sometimes scarcely perceptible. The infrapalatal fold is sometimes wanting and sometimes double.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.0	1.4	0.8	0.8	5
2.2	1.4	0.9	0.9	5
2.5	1.5	1.0	1.0	5
2.7	1.7	1.0	...	$5\frac{1}{2}$

Habitat: *Vertigo ovata*, although found in various parts of the state, lives only in moist environs afforded by shaded slopes near streams and shores of ponds. Its range in Kansas extends westward into the generally dry regions of the High Plains. In these regions are local ponds and streams, many of which are fed by artesian springs, along whose shaded slopes *V. ovata* is found, though not in great numbers. This species is not known from the Ozark Region, extreme southeastern Kansas.

In Kansas, the Recent distribution of this species, which is essentially a northern form, is sporadic. This is true even along tributary streams such as the Wakarusa River, a tributary of the Kansas River. A series of collections along this stream resulted in finding *V. ovata* at only one locality (Franzen and Leonard, 1943, text fig. 6, and p. 420).

V. ovata lived in Lower Pliocene times in Oklahoma, near the Kansas border (Leonard and Franzen, 1944, p. 30) and in Pleistocene times in Kansas when the climate was cooler and more humid than it is in that area at the present time. This species is probably now receding from Kansas because it is intolerant of the high temperatures coupled with the relative low humidity of the summer season.

Distribution:

Type locality: Philadelphia, Pennsylvania.

General distribution: Labrador, Alaska to Alabama, Texas, Arizona, Mexico and West Indies (Pilsbry, 1919, Vol. 25, pt. 98, p. 83). Pliocene, Beaver County, Oklahoma; Pleistocene, Kansas and Nebraska.

Distribution in Kansas:

Recent: Northeastern and northwestern Kansas, along the Kansas River and its tributaries; Southcentral Kansas, along the Arkansas River and its tributaries; Southwestern Kansas, along the Cimarron River and near lakes and ponds.

Pleistocene: Meade County: Jones Sink, S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E Meade (Locality number 13, Hibbard, 1940, p. 417); Lincoln County: Rezabek faunule, S 20, T 13 S, R 10 W, 8 mi. S, 16 mi. W of Lincoln; Lower Pleistocene: Meade County, Cudahy, Volcanic Ash Pit, SW¼, S 2, T 31 S, R 28 W, 6 mi. N of Meade; Sunbrite (Cudahy) S 26, T 32 S, R 28 W, 3 mi. S of Meade.

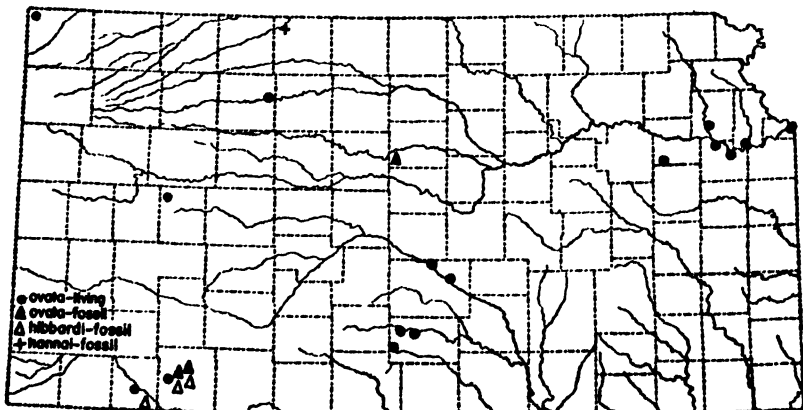


FIG. 9. Records of *Vertigo ovata* Say, *V. hannah* Pilsbry, and *V. hibbardi* F. C. Baker.

Vertigo elatior Sterki

Plate XX, fig. 2. Text figure 11.

Vertigo ventricosa elatior Sterki, 1894a, pp. 5-6; Pilsbry, 1919, Vol. 25, pt. 98, pp. 95-96, Pl. 7, fig. 6; Henderson, 1924, pp. 80, 136.

Vertigo elatior, Pilsbry, 1931, Vol. 28, pt. 110, pp. 93-95.

Description of the shell: Shell conic-ovate; summit obtuse; imate; nuclear whorl finely granular; whorls 5, convex, rapidly and regularly increasing in size, irregularly striate; body whorl one-half of total height, contracted at the base and expanding toward the aperture; aperture oblique, biarcuate, at least one-half the height of the ultimate whorl; folds and lamellae 5: a high, short angular lamella situated at the center of the parietal wall; two palatal folds situated on a palatal callus, a triangular upper palatal located at the place of the indenture of the outer lip, a somewhat more prominent and more deeply immersed lower palatal; a low, tubercular basal fold situated at the base of the columellar wall, a low, tubercular, columellar lamella, subvertical, ascending inwardly; peristome not everted, margin sharp, terminations approaching, connected across parietal wall by a thin callus; crest behind the lip usually prominent; linear impressions at the level of the upper and the lower palatal folds, the former sometimes incising the crest, the latter causing the body whorl to be constricted at the base.

Variations: Since only 8 specimens, all from the same population, were available for study, very little individual variation could be noted. Some of the shells lacked the definite palatal callus while this feature was well-developed in others. The characteristics of these shells compared favorably with those of the type lot of *Vertigo elatior* studied by the author in the Carnegie Museum, Pittsburgh.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.0	1.2	0.6	0.6	5
2.1	1.2	0.6	0.6	5

Habitat: *Vertigo elatior* prefers a cool humid climate characteristic of northern United States or mountainous areas of southern states. Cool and humid climatic conditions probably obtained in Kansas in the time this species lived in northwestern Kansas. Prolonged drought and high temperatures, characteristic of Kansas' summers, are factors excluding *V. elatior* from Kansas today.

Distribution:

Type locality: New Philadelphia, Ohio.

General distribution: Maine, New York, Ohio, Michigan, Montana, British

Columbia and Alberta, Orocuro Mts., Socorro County, N. Mexico. Loess, New Harmony, Indiana; marl deposits, Castalia, Erie County, Ohio (Pilsbry, 1919, Vol. 25, pt. 98, p. 95). Pleistocene in Kansas.

Distribution in Kansas:

Pleistocene: Sanborn Formation: Norton County; SE $\frac{1}{4}$, S 5, T 1 S, R 22 W, 9 $\frac{1}{2}$ mi. N, 4 $\frac{1}{2}$ mi. E of Norton.

Vertigo gouldii (Binney)

Plate XX, fig. 3. Text figure 10.

Pupa gouldii Binney, 1844, p. 105.

Vertigo gouldii, Pilsbry, 1919, Vol. 25, pt. 98, p. 98; Henderson, 1924, pp. 80, 137, fig. 40; Frye, Leonard, and Hibbard, 1943, p. 41.

Description of the shell: Shell ovate to elongate-oval; apex obtuse; rimate; whorls convex; nuclear whorl finely granular; remaining whorls weakly and irregularly striate (probably due to wear); whorls increasing rapidly and regularly in size; body whorl more than one-half total height; aperture scarcely oblique, biarcuate, somewhat expanded; denticles 5 to 6: a short lamelliform parietal lamella in the center of the parietal wall; a slightly elongate upper palatal fold; a slightly elongate, somewhat more deeply entering lower palatal fold; a tubercular basal fold; a low, tubercular, sub-columellar lamella appearing tubercular when viewed from without, ascending inwardly; folds not situated on a palatal callus; peristome not reflected, terminations approaching and connected across the parietal wall by a thin callus, margin slightly rounded, edge sharp; crest behind the lip usually prominent and separated from the peristome by a groove; sharp, linear impressions on the body whorl at the level of the upper and the lower palatal folds; body whorl constricted at the base and expanding towards the aperture.

Variations: Some of the shells are elongate while others tend to be more ovate. The basal fold is frequently wanting, though sometimes double. The crest behind the peristome is usually prominent, sometimes inconspicuous. In the shells from Kansas Pleistocene deposits, the sutures are more deeply and sharply incised than they are in Recent shells from southeastern United States with which comparisons were made. The Pleistocene shells are not as conspicuously striate as are the Recent shells, which may be due to wear.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.8	1.1	0.6	0.6	5
1.9	1.17	0.6	0.6	5
2.0	1.1	0.6	0.6	5

Habitat: In Kansas *V. gouldii* is known only from the Lower Pleistocene (Meade Formation). This species at the present time is limited in its distribution to regions where cooler and more humid climatic conditions obtain. It is very probable that in Lower Pleistocene times of Kansas, climatic conditions differed from those of the Recent times. Hibbard (1944, p. 741) has studied the vertebrate fauna of the Meade Formation and says, "The abundance of the *Sorex* and the associated *Neosorex*, *Microsorex*, *Synaptomys borealis*, and *Microtus* of the *operarius* group indicate that at the time they lived in southwestern Kansas the climate was considerably cooler and more humid than at present. This conclusion is based upon the habitats in which their nearest living relatives are found."

Distribution:

Type locality New England

General distribution Prince Edward and Magdalen Islands, British Columbia and Montana, Potomac River, North Carolina, mountains of Tennessee, Alabama (Pilsbry, 1919, Vol 25, pt 98, p 98) Pleistocene in Kansas

Distribution in Kansas

Pleistocene Meade Formation Meade County, Cudahy Volcanic Ash Pit S 2, T 31 S R 28 W, 6 mi N of Meade, Lincoln County, Wilson Valley deposit S 28, T 13 S, R 10 W, 9 mi S, 15 mi W of Lincoln

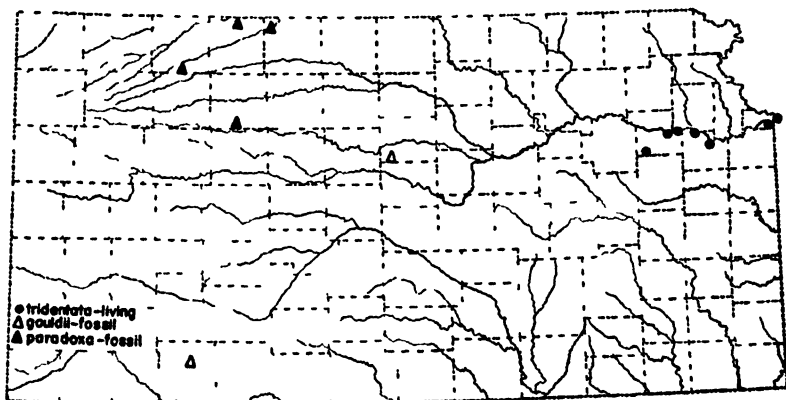


FIG 10 Records of *Vertigo gouldii* (Binney) *V. g. paradoxa* Sterki, and *V. tridentata* Wolf

Vertigo gouldii paradoxa Sterki

Plate XX, fig 4 Text figure 10

Vertigo gouldii paradoxa Sterki, in Nylander, 1900, p 103, Pilsbry, 1919, Vol 25, pt 98, pp. 99-100, Pl. 12, figs 6, 8 (a more complete description), Pilsbry, 1931, Vol. 28, pt. 110, p. 95.

Vertigo gouldii, Hanna and Johnston, 1913, pp 115, 120, Hibbard, Frye and Leonard, 1944, pp. 13, 14.

Vertigo coloradensis, Leonard and Frye, 1943, p 457, text fig 3, Hibbard, Frye, and Leonard, 1944, p. 13, fig 2.

Description of the shell: Shell moderate in size for the genus; oval; summit obtuse; rimate; suture incised; the $1\frac{1}{2}$ nuclear whorls white, finely granular; remaining whorls convex, irregularly and coarsely striate, rapidly and regularly increasing in size; body whorl somewhat more than half the total height, constricted at the base and expanding toward the aperture; aperture rounded, biarcuate; somewhat oblique; denticles 4 to 6; an elongate, lamelliform, parietal lamella situated on the center of the parietal wall, increasing gradually in height and terminating rapidly but not abruptly; an elongate lamelliform upper palatal fold; an elongate, more deeply entering, oblique, lower palatal fold; a low, tubercular basal fold; a columella lamella which appears to be tubercular when viewed from without, ascending inwardly; peristome not everted, margin slightly rounded, terminations approaching and connected across the parietal wall by a callus; crest behind the peristome prominent, broad, and separated from the peristome by a groove; sharp, linear impressions on the body whorl at the level of the upper and lower palatal folds.

Vertigo gouldii paradoxa differs from the typical form of the species in several respects. The lower palatal fold is deeply entering and the basal fold occasionally present in *V. g. paradoxa*, while the lower palatal fold enters subequally with the upper palatal fold, and the basal fold is usually present in *V. gouldii*. *V. g. paradoxa* differs from *V. hannai* Pilsbry in several ways. The columellar lamella ascends inwardly and the angular lamella is usually wanting, though occasionally present in *V. g. paradoxa*. The columellar lamella is horizontal and heavier in *V. hannai* than in *V. g. paradoxa*. The angular lamella is well-developed and consistently present in *V. hannai*.

Variations: Several features are subject to individual variation. The shape of the shell is oval to ovate. The position of the lower palatal fold varies considerably; in some individuals this fold is deeply entering, on the dorsal wall, and almost transverse to the axis while in other individuals it is somewhat shorter and not entering as deeply, approaching the condition in *V. gouldii*. A small lamella is occasionally present. The basal fold is sometimes wanting.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.88	1.1	0.6	0.6	5
1.9	1.1	0.6	0.6	5
2.1	1.1	0.6	0.6	5

Habitat: Since this pupillid is known in Kansas only from the Pleistocene, the ecological conditions under which it lived here is a matter of conjecture. Its inhabiting northern regions in North America at the present time signifies that it is a snail which prefers lower temperatures than now obtain in Kansas, especially in the summer season. This probably accounts for the absence of *V. g. paradoxa* from the Recent fauna of Kansas.

Distribution:

Type locality: Woodland, Aroostock County, Maine.

General distribution: Quebec (Pilsbry, 1919, Vol. 25, pt. 98, p. 100). Pleistocene in Kansas and Nebraska.

Distribution in Kansas:

Pleistocene: Long Island, Phillips County. The shells were collected from this locality by Hanna and Johnston (1913, pp. 112, 120, *Vertigo gouldii*). However, data regarding the locality and horizon are inadequate to assign the shells to the fauna of the Sanborn Formation, though the area from which they were obtained lies within its boundaries. Sanborn Formation: Decatur County, 1.4 mi. SW Dresden. Graham County, 15 mi. N of Wakeeney. Sheridan County, NW¼, S 34, T 8 S, R 28 W, 2 mi. S of Hoxie. Norton County, SE¼, S 5, T 1 S, R 22 W, 9½ mi. N, 3½ mi. E of Norton.

Vertigo tridentata Wolf

Plate XX, fig. 5. Text figure 10.

Vertigo tridentata Wolf, 1840, Amer. J. of Conch., May 5, p. 198 (Pilsbry, 1919, Vol. 25, pt. 98, p. 106); Hanna, 1909, p. 95; Pilsbry, 1919, Vol. 25, pt. 98, pp. 106-107, Pl. 12, figs. 1, 2, and 3; Henderson, 1924, pp. 81, 136; Franzen and Leonard 1943, p. 421, text fig. 6, Pl. XXXII, fig. 29.

Description of the shell: Shell oval to oblong; summit conic; rimate; whorls 5, nuclear whorl finely granular; remaining whorls finely and irregularly striate, increasing regularly and rapidly in size; body whorl more than half the total height, constricted at the base and expanding toward the margin; aperture pyriform, oblique, biarcuate, slightly expanding; denticles 4: a single, short, well-developed angular lamella; a low, tubercular lower palatal fold; a low columellar lamella, tubercular from without, entering horizontally and ascending inwardly; the two palatal folds are situated on a low callus which extends to the columellar lamella; terminations of peristome approaching, connected across the parietal wall by a thin callus; margin very narrowly reflected.

Variations: The most pronounced variant is the size which ranges from 2.1 mm. to 2.5 mm. The upper palatal fold is usually present, though sometimes low. The crest behind the peristome is sometimes scarcely perceptible.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.1	1.25	0.7	0.7	5
2.25	1.2	0.7	0.7	5
2.3	1.2	0.8	0.7	5

Habitat: Hanna (1909, p. 95) states that *Vertigo tridentata* is "Our commonest *Vertigo*; found on Blue Mound and in river drift at various places." Since that time *V. tridentata* has become less common. The author has found it in only one locality in Kansas, on a timbered bank of the Wakarusa River, a tributary to the Kansas River, 6 mi. W, $\frac{1}{2}$ mi. S of Auburn, Shawnee County. These specimens were recovered from local drift. No living specimens have been found.

Distribution:

Type locality: Canton, Illinois.

General distribution: Ontario, New York, New Jersey, Pennsylvania, Ohio, Indiana, Illinois, Minnesota, Michigan, Kansas, Colorado, Texas (Pilsbry, 1919, Vol. 25, pt. 98, p. 106).

Distribution in Kansas:

Recent: Reported from 7 localities along the Kansas River and tributaries, northeastern Kansas in Wyandotte, Douglas, and Shawnee counties.

Vertigo hannai Pilsbry

Plate XX, fig. 7. Text figure 9.

Vertigo martini Hanna and Johnston, 1913, p. 120, Pl. XVIII, fig. 3.

Vertigo hannai, Pilsbry, 1919, Vol. 25, pt. 98, pp. 114-115, Pl. 12, fig. 12.

Description of the shell: Shell of moderate size; ovate; summit obtuse; rimate; whorls $4\frac{1}{2}$ to 5, convex; the one and one-half nuclear whorls white, finely granulose; remaining whorls conspicuously and irregularly striate, regularly increasing in size; body whorl about one-third the total height; aperture about three-fifths of height of body whorl, ovate, oblique, slightly biarcuate, somewhat expanded; folds and lamellae 6; 2 lamellae on the parietal wall, equally immersed, the parietal lamella the larger, lamelliform; the angular, tubercular; two folds on the palatal side, a lamelliform, elongate, upper palatal fold and an equally entering, elongate, lamelliform, lower palatal fold, both increasing rapidly in height and decreasing gradually inwardly; two denticles on the columellar side; a tubercular basal fold and a shortly elongate, horizontal columellar lamella; peristome slightly reflected on the columellar side, terminations approaching and connected across the parietal wall by a conspicuous callus; margin rounded.

In the description of the holotype (Hanna and Johnston, 1913, p. 120), the columellar lamella is described as being bifid. Upon close examination of the holotype, No. 226396, The United States National Museum, the columella lamella is seen to be single, short and horizontal.

A well-developed angular lamella which is invariably present, a horizontal rather than ascending columellar lamella, a less pronounced indentation of the outer margin of the peristome, heavier palatal folds and a less prominent crest behind the peristome are characteristics which distinguish *V. hannai* from *V. gouldii* (Binney).

Variations: The individual variations of the 70 shells studied were small. The principal variants were a slight difference in the total height and in the size of the basal folds.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.8	1.1	0.6	0.6	4½
1.89	1.2	0.6	0.6	5
1.9	1.1	0.6	0.6	5
1.98	1.1	0.6	0.6	5

Habitat: *Vertigo hannai* lived in Kansas in Pleistocene times associated with several species of pupillids which are today found only in regions of cool and humid climatic conditions. This indicates that cool and humid climatic conditions obtained in Kansas at the time *V. hannai* lived here.

Distribution:

Type locality: Long Island, Phillips County, Kansas, in deposits presumably of Pleistocene age. Exact geological and geographical data are not available.

General distribution: Known only from the type locality.

Vertigo modesta (Say)

Plate XX, fig. 6. Text figure 11.

Pupa modesta Say, 1824, p. 359, Pl. 15, fig. 5.

Vertigo modesta, Hanna and Johnston, 1913, pp. 115, 120; Pilabry, 1919, Vol. 25, pt. 98, p. 123, Pl. 10, figs. 1, 2; p. 124, figs. 1, 2, 2a; Henderson, 1924, pp. 80, 137.

Vertigo tridentata, Leonard and Frye, 1943, p. 457.

Description of the shell: Shell ovately-conic; summit convex; moderate in size for the genus; rimate; suture deeply incised; whorls 4½ to 5, convex; nuclear whorl white and finely granular; remaining whorls coarsely and irregularly striate, rapidly increasing in size; body whorl more than half the total height; aperture ovate, outer peristome scarcely indented; denticles 3 to 4: a low, slightly

elongate parietal lamella; a low, tubercular upper palatal fold usually present; a lower palatal fold somewhat larger and elongate, entering equidistantly with the upper palatal fold; a low short, horizontally placed columellar lamella; palatal folds not on a callus; peristome not everted, terminations approaching and connected across the parietal wall by a thin callus; margin slightly rounded; a low crest behind the peristome sometimes present.

Several characteristics of the shell distinguish *Vertigo modesta* from *V. tridentata* Wolf. The palatal folds of *V. modesta* are not situated on a callus, the columella lamella is nodose, the sinulus of the outer margin of the peristome is scarcely perceptible. The palatal folds of *V. tridentata* are situated on a callus; the indentation of the outer margin of the aperture is more pronounced than it is in *V. modesta*; the columellar lamella ascends inwardly.

Variations: Usually all of the 4 denticles are present, although occasionally the upper palatal fold is wanting. The presence of the crest behind the peristome is variable. The most outstanding variable is the height of the shell which ranges from 1.98 mm. to 2.6 mm.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.6	1.35	0.9	0.7	5
2.4	1.4	0.9	0.7	5
2.2	1.2	0.8	0.7	4¾
1.98	1.17	0.7	0.6	5

Habitat: *Vertigo modesta* is a species inhabiting regions of humid, cool climate. It is abundant in Alaska.

Distribution:

Type locality: Northwest Territory, . . . "somewhere in northern Minnesota, southern Manitoba, or near the western end of Lake Superior, on the route of Major Long's second expedition" (Pilsbry and Vanatta, 1909, p. 601).

General distribution: Labrador to Victoria and Nanaimo, Alaska; Maine, Vermont, and Connecticut. Loess of Iowa and Kansas. Pleistocene in Nebraska.

Distribution in Kansas:

Recent: Jefferson County, 2.2 mi. NW of Valley Falls, along Cedar Creek, one dead shell from drift. Geologic age doubtful.

Pleistocene: Northwestern Kansas, Sanborn Formation: Decatur County: 1.4 mi. SW of Dresden; 1½ mi. E of the eastern city limits of Oberlin; NW¼, S 15, T 3 S, R 29 W, 1 mi. S, 2 mi. W of Oberlin. Norton County: SW¼, S 11, T 1 S, R 25 W, 8½ mi. N, 12 mi. W of Norton; SE¼, S 5, T 1 S, R 22 W, 9½ mi. N, 4 mi. E of Norton;

SE¼, S 13, T 1 S, R 24 W, 7½ mi. N, 4 mi. W of Norton; Norton-Phillips County line, US Hgwy. 36, roadcut. Graham County: 2½ mi. W of the eastern border of Graham County, US Hgwy. 24. Phillips County: Long Island

Because *Vertigo modesta* is a species which prefers cool and humid climates, it has receded from Kansas since Pleistocene times.

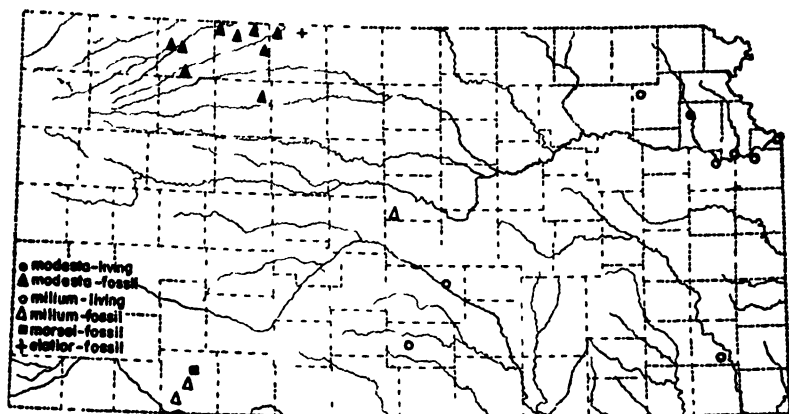


FIG 11 Records of *Vertigo morsei* Sterki, *V. elator* Sterki, *V. modesta* (Say), and *V. milium* (Gould).

Vertigo milium (Gould)

Plate XX, fig 8 Text figure 11.

Pupa milium Gould, 1840, p 402

Vertigo milium, Hanna, 1909, p 95, Pilsbry, 1919, Vol 25, pt 99, pp. 146-149; Henderson, 1942, pp 80, 139; Lugin, 1935, Table C, p 212, Frye and Hibbard, 1941, p. 408; Hibbard, 1941, p 265, Over, 1942, p 9, Frye, Leonard and Hibbard, 1943, p. 41.

Description of the shell: Shell small, the smallest of the genus represented in Kansas; ovate to somewhat cylindric in form; height varying from 1.53 mm. to 1.9 mm ; rimate; whorls 4½ to 5, convex but not inflated, finely and irregularly striate, gradually and regularly increasing in size; body whorl relatively large, more than half of total height of shell, contracted at the base and expanding toward the aperture; aperture slightly more than one-half the height of the body whorl, ovate, somewhat oblique, strongly biarcuate, expanding toward the peristome; peristome slightly everted, margin sharp, terminations approaching and continued across the parietal wall by a thin callus; denticles 5: an elongate lamelliform parietal lamella, increasing in height inwardly and terminating abruptly; a smaller, nearly tubercular, less deeply immersed angular lamella; an elongate lamelliform upper palatal fold, rapidly increasing in

height and terminating gradually; a slightly more deeply entering lower palatal fold whose inner third is bent toward the columella usually at an angle greater than 90° , although occasionally at 90° ; a low, slightly elongated basalar; a short, crescentic columellar lamella situated on the central portion of the columellar wall; crest behind the peristome prominent, usually rounded though sometimes sharp; linear impressions on the body whorl at the level of the upper and the lower palatal fold, the former incising the crest.

Variations: Two characters subject to individual variation are the general form and size of the shell and the degree of the curvature of the lower palatal fold. The extreme variation in height of Kansas shells, in specimens available, fossil as well as Recent, is $0.3+$ mm. (see table of measurements). The degree of the curvature of the lower palatal fold varies approximately from an angle of about 140° to one of 90° . Extremes of this variation occur in specimens of the same population, fossil as well as Recent. The full degree of variation is noted particularly in specimens from two populations, (a) a series from the Cudahy fauna, Meade Formation, Lower Pleistocene, 6 mi. N of Meade, Meade County, in which the degree of curvature in some instances was a 90° angle, and approaching 140° in others; (b) a lot of Recent shells from Kansas City, Wyandotte County, collected by Hanna, perhaps from drift. In this group the lower palatal fold of a single individual curved at a 90° angle whereas in the other specimens of the same lot it curved at an angle greater than 90° . In populations varying in age from Pliocene to Recent, the general tendency is for the curvature to approach an angle greater than 90° . Since the degrees of these variations are not limited to, nor found to be consistent in any locality or geologic age, they are obviously characters of individual variation and not specific characters.

Vertigo milium has not become modified from Upper Pliocene (?) to the present time. The fossil shells, except for the difference in texture and color, cannot be separated from the Recent shells. The individuals from Kansas do not differ from those of localities in Arkansas, Oklahoma, Illinois, Alabama and Texas.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.6	1.08	0.6	0.6	$4\frac{1}{2}$
1.7	1.1	0.6	0.6	5
1.8	1.08	0.6	0.6	5
1.89	1.1	0.6	0.6	5
1.9	1.1	0.6	0.6	5

Habitat: Moist situations afforded by timbered stream banks, or marshes. It is not found in areas of low relative humidity or low annual precipitation and high summer temperatures, features which are characteristic of the climate of the western half of the state.

Although *Vertigo milium* lived in the western part of Kansas in Pliocene (?) and Pleistocene times, climatic conditions such as prolonged drought in the summer, low annual precipitation and low relative humidity, exclude it from that area today. It is living in isolated localities in the eastern part of the state which indicates that it is receding from this part of the country because conditions are no longer at an optimum.

Distribution:

Type locality: Oak Island, Chelsea, near Boston, Mass.

General distribution: Maine to Florida, South Dakota, Colorado, Arizona, Mexico, and Jamaica (Pilsbry, 1918-1920, pp. 146-149). Recent and Pleistocene in Kansas. Pleistocene in Nebraska.

Distribution in Kansas:

Recent: In northeastern, southeastern and southcentral Kansas.

Pleistocene: Meade Formation: Lincoln County, Wilson Valley deposit, NE $\frac{1}{4}$, S 28, T 13 S, R 10 W, 9 mi. S, 15 mi. W of Lincoln; Meade County, Cudahy Volcanic Ash Pit, SW $\frac{1}{4}$, S 2, T 31 S, R 28 W, 6 mi. N of Meade.

Blancan: Meade County, Rexroad deposit, SW $\frac{1}{4}$, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade.

Upper Pliocene (?): Seward County, Saw Rock Canyon deposit, S 35, T 34 S, R 31 W, 14 mi. E of Liberal.

Vertigo hibbardi F. C. Baker

Plate XX, figs. 9, 10. Text figure 9.

Vertigo hibbardi F. C. Baker, 1938, pp. 126-127; Baker in Hibbard, 1941, p. 95; Frye, Leonard and Hibbard, 1943, p. 42; Hibbard, 1943, p. 236.

Description of the shell: Shell moderate in size for the genus; ovately conic; rimate; whorls typically 5, convex; suture sharply incised; nuclear whorl finely granulose; remaining whorls glossy, and finely striate in well-preserved shells, regularly and rapidly increasing in size; body whorl as much as $\frac{3}{5}$ of total height; aperture biarcuate, expanding toward the peristome; peristome narrowly reflected, margins sharp, terminations approaching and connected across parietal wall by a thin callus; denticles 7: 2 elongate lamellae on parietal wall, the parietal lamella the more deeply immersed, the innermost third deflected at a right angle toward the outer lip; the angular about $\frac{1}{3}$ as long as the parietal, less deeply immersed; suprapalatal fold, when present, tubercular; upper palatal fold

lamelliform, high, long and sinuous; lower palatal fold lamelliform, more deeply immersed than the upper palatal, increasing in height up to its midpoint and then declining, partially forked anteriorly; infrapalatal low, elongate, as deeply immersed, and about half as long as the lower palatal; basal, lamelliform, elongate, increasing in height inwardly and terminating rather abruptly; the folds connected by a low callus; columellar lamella large, heavy, crescentic, ascending slightly toward the columella, then turning downward and recurving slightly forward at the base; crest behind the peristome prominent, rounded, separated from the peristome by a groove; body whorl indented at level of the upper and lower palatals resulting in the contraction of the body whorl at its base.

Variations: A large series of specimens, totaling 320 individuals from 3 populations, which were available for study, indicate that *Vertigo hibbardi* is only slightly variable. The lamellae and folds are constant in occurrence and position. The suprapalatal fold varies in degree of prominence. There is some individual variation in the total height and consequently the general shape of the shell. The largest shells are conic and the smaller shells are ovate. The difference in height between the largest and the smallest individuals is 0.5 mm. Occasionally the crest behind the peristome is low, but usually it is prominent.

Although *Vertigo hibbardi* has been found in only 3 localities, the number of specimens indicates that this species was well represented in Kansas from the Pliocene to Blancan times. Apparently this was one of the dominant species of the genus in this area.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
1.9	1.3	0.9	0.9	4½
2.1	1.4	0.8	0.7	5
2.2	1.5	0.9	0.9	5
2.4	1.5	0.9	0.9	5

Habitat: The terrestrial gastropods associated with *Vertigo hibbardi* (Baker in Hibbard, 1941a, p. 95) in the Rexroad Ranch deposits are for the most part woodland snails. Hibbard (1941a, pp. 94-101) after studying the vertebrate fauna of the Rexroad Ranch deposits, concluded that meadows, marshes and trees existed along the valley of a major stream which flowed through the region. The presence of shrews and voles indicates summers of lower temperatures and of greater humidity than obtain in southwestern Kansas

today. At the time these deposits were laid down, there was probably an absence of extreme summer droughts.

Distribution:

Distribution in Kansas:

Type locality: Designated only as Pliocene, Meade County, Kansas, Baker, 1938, pp. 126-127. Hibbard (1941, p. 265), collector of the type and paratypes, assigns the type locality as Meade County, Kansas, locality number 3, Rexroad deposit, SW $\frac{1}{4}$, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade, Blancan age.

Blancan: Type locality. Big Springs, 2 mi. S, 4 mi. W of Meade.

Upper Pliocene:

Seward County: Saw Rock Canyon deposit, S 35, T 34 S, R 31 W, 14 mi. E of Liberal.

Genus *Pupoides* Pfeiffer

Pupoides Pfeiffer, 1854, p. 192; Pilsbry and Vanatta, 1900, p. 585. "Kobelt, Syst. Conchylien-Cabinet, Buliminidae, p. 917.—Iredale, Proc. Malac. Soc. Lond., xi, p. 176.—Gude, Fauna of British India, Moll., ii, 1914, p. 259, *P. nitidulus* selected as type.

Leucochila v. Martens in Albers, Die Heliceen, 1860, p. 296, type by original designation *Pupa fallax* (= *P. marginatus* Say).

Leucochiloides Pfeiffer, Nomencl. Hel. Viv., 1878, p. 292. *B. lardeus* (Pfeiffer), designated as type by Connolly, Ann. S. Afr. Mus., xi, 1912, p. 176." (Pilsbry, 1921, Vol. 26, pt. 102, p. 108).

Pupoides, Pilsbry, 1921, Vol. 26, pt. 102, pp. 108-147, Pl. 11, figs. 10-12, 14-15; Pl. 12; Pl. 13; Pl. 14, figs. 1-7, 8-11; Pl. 15; Pl. 17, figs. 1-6. Pilsbry, 1926, Vol. 27, pt. 108, pp. 248-253, Pl. 31, figs. 10-13, 15. Pilsbry, 1931, Vol. 28, pt. 110, pp. 80-81, Pl. 18, fig. 8. Pilsbry, 1934, Vol. 29, Pt. 111, pp. 137-138. Pilsbry, 1935, Vol. 28, Pt. 113, pp. 200-201.

Characteristics of the shell: Shell elongate-conic to oval; summit sharply obtuse to convex; total height ranging from 3.3 mm. to 5.6 mm.; whorls 4 $\frac{1}{2}$ to 6 $\frac{1}{2}$, regularly and rapidly increasing in size; ultimate whorl exceeding one-half total height; peristome expanded, terminations approaching, connected across parietal wall by a thin callus; aperture ovate, usually edentulous; angular lamella, if present, marginal and tubercular, situated at the outer parietal and upper palatal angle; rimate to minutely perforate.

Distribution:

Recent: North America, West Indies, South America, Arabia, Africa, India, Australia (Pilsbry, 1934, Vol. 28, pt. 111, pp. 139-168).

Pleistocene: North America.

Pliocene: North America.

KEY TO SPECIES

1. Peristome widely reflected. Sinulus present at upper lateral angle of aperture, *P. marginatus*
- Peristome not widely reflected 2
2. Surface finely striate *P. inornatus*
- Surface costate *P. hordaceus*

Pupoides marginatus (Say)

Plate XXI, figs. 3 & 4. Text figure 13.

Cyclostoma marginatus Say, 1821, pp. 172-173.

Pupoides marginatus, Hanna, 1909, p. 94; Hanna and Johnston, 1912, p. 113; Hanna, 1920, p. 19; Pilsbry, 1921, Vol. 26, pt. 102, pp. 111-113, Pl. 12, figs. 1-7; Henderson, 1924, p. 79; Hibbard, 1940, p. 418; Hibbard, 1941, p. 313; Frye and Hibbard, 1941, p. 408; Over, 1942, p. 8; Fransen and Leonard, 1942, p. 339, Pl. I, fig. 12; Fransen and Leonard, 1943, pp. 421-422, text fig. 6, Pl. XXXII, fig. 30; Leonard, Alice, 1943, p. 339, Pl. I, fig. 12; Leonard and Fransen, 1944, p. 30, Pl. V, fig. 18; Leonard and Leonard, 1945, p. 120.

Description of the shell: Elongate-conic, summit obtuse; rimate, color brown; shell heavy, somewhat translucent; suture sharply and deeply incised; whorls $4\frac{1}{2}$ to $6\frac{1}{2}$, convex, increasing regularly and rapidly in size; body whorl more than one-half total height of shell; $1\frac{1}{2}$ nuclear whorls finely granular; remaining whorls finely, closely and irregularly striate giving the surface a silky appearance; aperture large ovate with a pronounced angular sinulus at upper corner of outer lip; peristome heavy, widely and flatly reflected, thickened within, terminations approaching and connected across parietal wall by a thin callus; margin sharp.

Variations: Several characters of the shell of *P. marginatus* are variable. The size ranges from 3.7 mm. \times 2 mm. to 5.6 mm. \times 2.6 mm.; the width does not vary in proportion to the height, thus making for a variation in the general shape of the shell. A prominent variable is the width of the peristome. The peristome varies from one narrowly reflected, about 0.2 mm. wide, to one attaining a width of about 0.4 mm., Plate VII, figs. 3, 4. The sinulus varies in size and shape. It may be shallow or very pronounced, rounded or angular. A tubercular callus at the upper extremity of the sinulus is pronounced, weakly developed, or wanting. In a few shells faint spiral striations are visible on the penultimate whorl.

This species is almost ubiquitous in the known Pliocene, Upper Pleistocene and Recent faunas under consideration. None of the several variations is restricted to any one population, but occurs in specimens of any of the several geologic ages or geographic localities.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
3.7	1.98	1.5	1.4	5
3.9	1.9	1.5	1.4	$5\frac{1}{4}$
4.2	2.1	1.7	1.4	$5\frac{1}{2}$
4.8	2.2	1.8	1.5	6
5.5	2.4	1.9	1.6	$6\frac{1}{4}$
5.6	2.4	2.0	1.6	$6\frac{1}{2}$

Habitat: This species, tolerant of high summer temperatures and drought, is found in woodlands, in deep grass, or even among the roots of short grass in unshaded areas.

Distribution:

Type locality: Upper Missouri.

General distribution: Maine and Ontario, south to the Gulf of Mexico, west to the Dakotas, western Arizona; northeastern Mexico to Cuba, Haiti, San Domingo, Porto Rico, Bermuda (Pilsbry, 1921, Vol. 26, pt. 102, p. 111). Kansas. Pleistocene in Nebraska. Oklahoma Pliocene, Beaver County, Oklahoma.

Distribution in Kansas:

Recent: Its occurrence in Kansas is general.

Pleistocene: Sanborn Formation: Wallace County, SW $\frac{1}{4}$, S 19, T 12 S, R 41 W, 6 mi. N, 10 mi. W of Sharon Springs. Meade County: Jones Sink, S 8, T 33 S, R 27 W, 5 mi. S, 3 $\frac{1}{2}$ mi. E of Meade, locality number 13 (Hibbard, 1940, p. 417); XI Ranch, S 33, T 34 S, R 29 W. Clark County: Pyle Ranch, S 11, T 30 S, R 23 W, above the Pearlette Ash.

Blancan: Meade County: Big Springs Ranch, NW $\frac{1}{4}$, NW $\frac{1}{4}$, S 19, T 32 S, R 28 W, 2 mi. S, 4 mi. W of Meade; Rexroad Ranch, SW $\frac{1}{4}$, S 22, T 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade; Fox Canyon, S 35, T 34 S, R 30 W, 17 mi. S, 12 mi. W of Meade.

Pliocene: Seward County, Saw Rock Canyon, S 35, T 34 S, R 31 W. Lower Pliocene, Beaver County, Oklahoma, Laverne Formation (Leonard and Franzen, 1944, p. 17).

Pupoides marginatus is known from the Lower Pliocene, Laverne Formation, Beaver County, Oklahoma; it occurs in Kansas in the one known Upper Pliocene (?) deposit, and in the several known deposits of Blancan age. It occurs in the Upper Pleistocene deposits in northwestern Kansas, the Sanborn Formation, as well as in the Upper Pleistocene in southwestern Kansas, Jones Sink, Pyle Ranch and the XI Ranch. No shells have been found in any of the several localities of the Meade Formation. However, one would expect to find this species in the Lower Pleistocene since it is found in the immediately earlier and later deposits in southwestern Kansas. Since it has a strong shell, it is readily preserved and more intensive collecting will probably result in its appearance in the Meade Formation.

Pupoides marginatus is the only representative of the genus in the Recent fauna of Kansas, with the exception of the few shells of *P. hordaceus* and *P. inornatus* whose geographic origin is doubtful since they are very likely from drift.

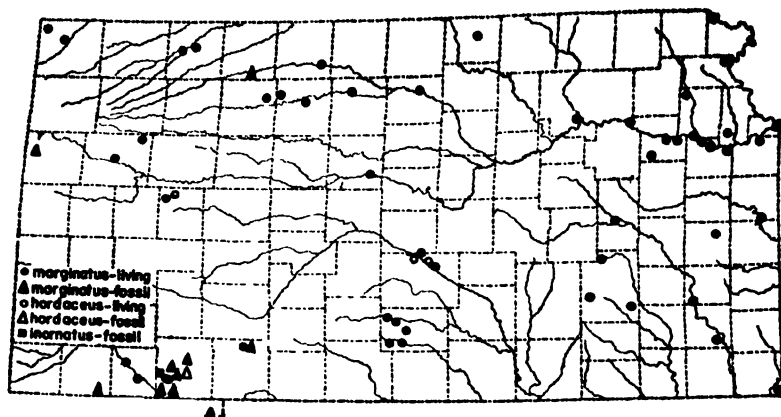


FIG. 12. Records of *Pupoides marginatus* (Say), *P. hordaceus* (Gabb), and *P. inornatus* Vannata.

Pupoides hordaceus (Gabb)

Plate XXI, fig. 2. Text figure 12.

Pupa hordacea Gabb, 1866, p. 331, Pl. 21, fig. 7.

Pupoides hordaceus, Pilsbry, 1921, Vol. 26, pt. 102, pp. 116-118; Henderson, 1924, pp. 79, 132, fig. 35.

Pupoides inornatus, Goodrich, 1940, p. 77; Hibbard, 1940, p. 418.

Description of the shell: Shell elongate, oval; summit obtuse; color auburn; suture sharply and deeply incised; whorls $5\frac{1}{2}$, convex, slightly shouldered above, body whorl slightly flattened; $1\frac{1}{2}$ nuclear whorls, white, finely granular; remaining whorls marked with low but conspicuous, widely-spaced, oblique costae; body whorl more than half the total height of the shell; aperture oblique, oval, without sinulus, edentulous; peristome very slightly reflected at the outer margin and becoming increasingly reflected toward the columellar margin, thickened within; margin rounded; terminations approaching and connected across parietal wall by a thin callus.

Variations: Due to the simplicity of the shell, not many characters are subject to variation. The height of the shells of the small series available ranges from 3.3 mm.-3.9 mm. The umbilicus, usually closed, is very small when open. The costae, distinctive of the species, are prominent. Sometimes, probably due to wear, they are rather faint and irregular in occurrence.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
3.3	1.5	1.2	1.2	$4\frac{1}{2}$
3.6	1.5	1.3	1.17	$4\frac{1}{2}$
3.8	1.6	1.3	1.17	$4\frac{1}{2}$
3.9	1.7	1.4	1.2	$5\frac{1}{2}$

Habitat: According to Pilsbry (1921, Vol. 26, pt. 102, p. 117), *P. hordaceus* is a southwestern form. It is a species presumably not found north and east beyond San Miguel County, in southwestern Colorado. "By correspondence with Junius Henderson and the examination of specimens it appears that all published records for *hordaceus* were based on specimens of *inornatus*, with the possible exception of Sampson's Williams canyon record (*Nautilus*, vi, 102) which has not been reexamined. The true *P. hordaceus* is known to occur only in the extreme southwestern part of the state, west of the Rocky Mountains." (Pilsbry, Vol. 26, pt. 102, p. 119.) Its habitat is in the arid plateaus and foothills. "It is known by specimens taken in the debris of streams or in Pleistocene or later deposits." (*Ibid*, p. 117.)

Shells from 4 Kansas localities were available for study. Of these, two series were obtained from localities along the Arkansas River at Hutchinson and Nickerson, Reno County. Some of these shells were bleached while others, though dead, were not bleached. Since the Arkansas River heads in the Rocky Mountains, it is possible these shells were in drift which originated near the headwaters. Nevertheless, the Arkansas River heads east of the Rocky Mountain divide. The occurrence of *P. hordaceus* in the debris of this river would extend its range eastward of previous records.

A small series of dead shells was obtained by Hanna from a locality near Healy, Lane County. The origin of these shells is not known. The town of Healy is not located near a major stream in which the shells could have been found in drift.

A series of 3 shells of *P. hordaceus* was obtained from the Upper Pleistocene of the Jones Sink, Meade County. The gastropod Jones faunule in general (Hibbard, 1940, p. 418), including such species as *Pupilla blandi*, and *Vertigo ovata*, indicates that a cooler temperature prevailed in southwestern Kansas in Upper Pleistocene times than obtains at the present time. Some of the species represented in the Jones fauna are typical of the fauna of a humid climate. However, it is probable that semiarid conditions obtained locally and that *P. hordaceus* was washed from nearby plateaus and deposited in a stream.

Distribution:

Type locality: Ft. Grant, Pinal County, Arizona.

General distribution: Southwestern Colorado, New Mexico and Arizona (Pilsbry, 1921, Vol. 26, pt. 102, p. 116); southwestern Kansas. Pleistocene of Kansas.

Distribution in Kansas:

Recent: Healy, Lane County (dead shells); Hutchinson and Nickerson, Reno County (probably from drift).

Pleistocene: Jones Sink, Upper Pleistocene, Meade County, S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E of Meade.

Pupoides inornatus Vanatta

Plate XXI, fig. 1. Text figure 12.

Pupoides inornatus Vanatta, 1915, pp. 95-96; Pilsbry, 1921, Vol. 26, pt. 102, pp. 118-119, Pl. 12, fig. 10; Henderson, 1924, pp. 132-133; Baker in Hibbard, 1941, p. 265; Over, 1942, p. 8.

Description of the shell: Moderate in size for the genus; elongate-oval; tapering toward the convex summit; minutely perforate; light cinnamon brown in color; suture incised; whorls 5½, convex and decreasing in convexity toward the ultimate whorl, increasing regularly and rapidly in height; body whorl more than one-half total height of shell; 1½ nuclear whorls, white, finely granular; remaining whorls finely and irregularly striate; aperture ovate, oblique, edentulous; peristome simple, reflected only on the columellar side; margin blunt; terminations approaching and connected across parietal wall by a thin callus.

Variations: Since only one individual was available from a Kansas locality, no comparison could be made. This shell, however, closely resembles the holotype, No. 110977, The Academy of Natural Sciences of Philadelphia.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
3.4	1.53	1.17	1.1	5½

Habitat: This single individual of *Pupoides inornatus* was taken from the flood plain of the Arickaree River, Cheyenne County. The Arickaree River heads in eastern Colorado near the foothills of the Rocky Mountains. The flood plain of the Arickaree River had been recently flooded when this shell was taken, so it is not unlikely that this shell may have been brought down from eastern Colorado. According to Pilsbry (1921, vol. 26, pt. 102, p. 119), *Pupoides inornatus* ". . . appears to be a species of the Rocky Mountains, spreading eastward . . ."

Distribution:

Type locality: Drift of White River, Washington County, South Dakota.

General Distribution: South Dakota, Colorado, New Mexico (Pilsbry, 1921, Vol. 26, pt. 102, p. 118).

Distribution in Kansas:

Recent: Flood plain of the Arickaree River, Cheyenne County, **Kansas**.
Blancan: Rexroad, Meade County, Locality number 3 (Hibbard, 1941, p. 265), SW $\frac{1}{4}$, S 22, R 33 S, R 29 W, 9 mi. S, 7 mi. W of Meade. The shells from this locality were studied by F. C. Baker and reported by Hibbard (1941, p. 265). They are not available for study at this time.

Genus *Pupilla* Leach

"*Pupilla* Leach in Turton, Man. Land and Freshwater Shells of the British Islands, 1881, p. 99.—Gray, P. Z. S., 1847, p. 176 (type *P. muscorum*).—Herrmannsen, Ind. Gen. Malac., ii, p. 362 (typus: *Pupa muscorum* L.).—Cockerell, Nautilus, xviii, 1905, p. 104.

Torquatella Held, Isis, 1837, p. 919, for *P. muscorum* L. and *P. triplicata* Studer.—Herrmannsen, Ind. Gen. Malac., ii, p. 583, "type *P. muscorum* L." "Pupa of most authors." (Pilsbry, 1921, Vol. 26, pt. 103, p. 152.)

Pupilla, Pilsbry, 1921, Vol. 126, pt. 103, pp. 152-225, Pl. 16; Pl. 17, figs. 8-18; Pl. 18, 19; Pl. 20, figs. 1-10, 12-20, 22-24; Pl. 21, 22; Pl. 23, figs. 1-21. 1931, Vol. 28, pt. 110, pp. 81-86.

Characteristics of the shell: Shell cylindrical, summit broadly convex; moderately large to large for the family, height ranging from 2.5 mm. to 3.9 mm.; rimate to minutely perforate; ultimate whorl less than one-half of total height; aperture irregularly oval; folds and lamellae 0-3: a parietal lamella, a lower palatal fold, a columellar lamella; peristome reflected, terminations approaching and connected across parietal wall by a thin callus; crest on ultimate whorl paralleling the peristome.

Distribution:

Recent: North America, Europe, North Africa, Cape Verde Islands, Reunion Island, Asia, Australia, in temperate and cool regions. (Pilsbry, 1921, Vol. 26, pt. 103, p. 154.)

Pleistocene: Kansas, Nebraska.

Pliocene: North America (Pilsbry, 1921, Vol. 26, pt. 103, p. 154).

Miocene: Central Europe (Ibid)

Upper Oligocene: Central Europe (Ibid)

KEY TO PUPILLA

1. Aperture characteristically tridentate. Denticles prominent.....*P. blandi*
 Aperture characteristically edentulous. Denticles, if present, small..... 2
2. Dextral*P. muscorum*
 Sinistral*P. muscorum sinistra*

***Pupilla muscorum* (Linnaeus)**

Plate XXII, fig. 2. Text figure 13.

Turbo muscorum Linnaeus, 1758, p. 767.

Pupilla muscorum, Hanna, 1909, p. 94; Hanna and Johnston, 1913, pp. 118-119; Pilsbry, 1921, Vol. 26, pt. 103, pp. 156-159; Hanna, 1920, p. 19; Henderson, 1924, pp. 79, 134; Lugs, 1935, p. 212; Over, 1942, p. 9; Frye, Leonard and Hibbard, 1943, p. 41; Leonard and Frye, 1943, pp. 457, 459; Hibbard, Leonard and Frye, 1944, pp. 13, 14.

Pupilla hebes, Frye, Leonard and Hibbard, 1943, p. 41; Leonard and Frye, 1943, pp. 457, 458; Hibbard, Frye, and Leonard, 1944, pp. 13, 14.

Description of the shell: Shell moderate to large in size ovate to cylindrically-ovate; height 2.9 mm.—3.9 mm.; rimate with an open umbilicus; suture sharply but not deeply incised; whorls $5\frac{3}{4}$ to 7, convex but not inflated; the $1\frac{1}{2}$ nuclear whorls finely granular; remaining whorls finely and irregularly striate, slowly and regularly increasing in size; body whorl less than half of the total height of the shell, contracted at the base and expanding toward the aperture; a prominent, rounded crest paralleling the peristome and removed from it by a deep groove; aperture truncately oval, slightly oblique, edentulous; peristome sharply everted, margins sharp, terminations approaching and connected across the parietal wall by a thin callus.

Variations: *Pupilla muscorum* is typically edentulous. Folds and lamellae, if present, are small and tubercular (Pilsbry, 1921, Vol. 26, pt. 103, pp. 156, 158). The majority of the shells identified as *P. muscorum* are edentulous, although a few shells have a low, tubercular parietal lamella. In some instances shells were encountered bearing a very low but elongate parietal, making specific identification difficult and problematical. The range of variation in size is within 1 mm. Shells of any one population are not restricted to any certain size, shape, number of whorls, or pattern of dentition.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.9	1.6	1.0	0.9	6
3.2	1.8	1.1	1.0	$6\frac{1}{2}$
3.6	1.8	1.1	1.1	7
3.9	1.9	1.2	1.3	$6\frac{1}{2}$

Habitat: Lives in regions having a cool, humid climate. Is found living on the ground, under wood, stones and leaves.

Distribution:

Type locality: Europe, on mossy ground.

General distribution: Palaearctic Region, generally over Europe, north Africa, northern and central Asia, south to Persia. North America: Eastern North America from Anticosti Island south to New Jersey; westward in Canada, northern tier of the States, north to Alaska, Rocky Mountain Region from Colorado south to New Mexico and northern Arizona. Loess of Iowa. (Pilsbry, 1921, Vol. 26, pt. 103, pp. 157, 174.) Pleistocene of Kansas and Nebraska.

Distribution in Kansas:

Pleistocene: Sanborn Formation: Norton County: 13 mi. S, 10 mi. E of Norton; $2\frac{1}{2}$ mi. E, 10 mi. N of Norton; 3 mi. S, $5\frac{1}{2}$ mi. W of Norton; $8\frac{1}{2}$ mi. N, 4 mi. W of Norton; $3\frac{1}{2}$ mi. E, 10 mi. N of Norton; $6\frac{1}{2}$ mi. W, 9 mi. N of Norton; Norton-Phillips County line, U. S. Hgwy. 36. Thomas County: 16 mi. S, $3\frac{1}{2}$ mi. W of Colby. Sheridan County:

2½ mi. W of Seldon; 4 mi W of Seldon. Wichita County: 15 mi. N of Leoti. Sherman County 14 mi S, 15 mi. E of Goodland. Decatur County: 1.4 mi. E of Dresden; 8.6 mi. E of Oberlin; 13 mi. S, 6 mi. E of Oberlin; 14 mi W, SW of Dresden. Phillips County: Long Island. Graham County: 15 mi. N of Wakeeny. Meade Formation: Wilson Valley Faunule, S 28, T 13 S, R 10 W, 9 mi. S, 15 mi. W of Lincoln, Lincoln County. Hanna collected this species from Topeka in Shawnee County, and from Lawrence in Douglas County; in either case probably from drift in the Kansas River.

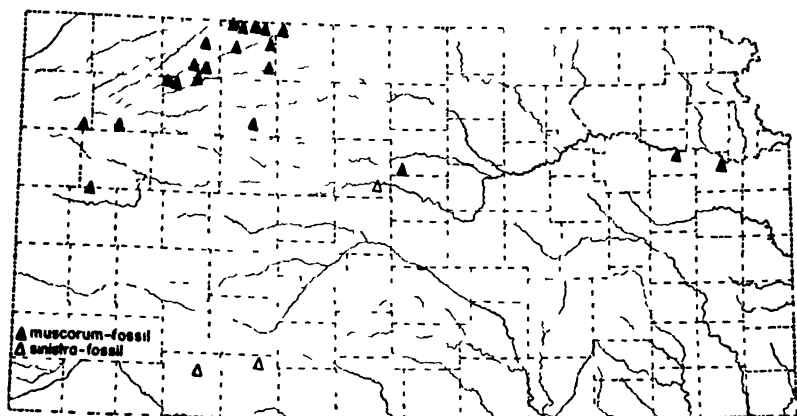


FIG. 13. Records of *Pupilla muscorum* (Linnaeus) and *P. m. sinistra* Franzen.

Pupilla muscorum sinistra Franzen

Plate XXII, fig 4 Text figure 13

Pupilla muscorum sinistra Franzen, 1946, pp 24-25

Description of the shell: "Shell sinistral, subcylindric, summit obtuse; whorls 7½, increasing regularly and gradually in height, convex; suture incised; greatest diameter at level of fifth whorl of spire from which the shell tapers to a constricted base; nuclear whorl finely granular; remaining whorls finely and irregularly striate; aperture ovate, oblique; lip reflected, thickened within by a low, rounded callus; peristrome sharp, continuous across parietal wall by a thin callus; dentition consisting of a single, low, elongate parietal lamellae; crest behind lip high and round."

Variations: "Size is the only appreciable variable among the paratypes. The parietal lamella is wanting in only a few specimens. A small lower palatal fold occurs rarely. The greatest diameter of the type specimen is at the level of the fifth whorl while in some of the paratypes the greatest diameter is at the level of the fourth whorl." (Franzen, 1946.)

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Type (3728)	3.9	1.9	1.25	1.08	7½
Paratype (3827)	3.8	1.8	1.25	0.9	7½
Paratype (3827)	3.7	1.8	1.08	0.9	7
Paratype (3827)	3.4	1.8	1.08	0.9	7
Paratype (3827)	3.2	1.7	1.08	0.9	7
Paratype (3828)	4.0	1.7	1.25	...	7½

Habitat: Known only from the Meade formation, Lower Pleistocene.

Distribution:

Type locality: Pyle Ranch, Clark County, Kansas, NE¼, S 11, T 30 S, R 23 W; Lower Pleistocene, Meade Formation.

Distribution in Kansas:

Pleistocene: Meade Formation: The type locality.

Tobin faunule, Russell County, S 35, T 14 S, R 11 W, 5½ mi. S, 18 mi. E of Russell. Cudahy faunule, S 2, T 31 S, R 28 W, 6 mi. N of Meade.

Pupilla blandi Morse

Plate XXII, fig. 1. Text figure 12.

Pupilla blandi Morse, Ann. Lyc. N. H. of N. Y., viii, 1865, p. 5, fig. 8; Hanna, 1909, p. 94; Hanna, 1913, p. 119; Henderson, 1924, p. 134; Over, 1942, p. 9; Hibbard, Frye and Leonard, 1944, pp. 13, 14.

Vertigo modesta, Goodrich, 1940, p. 77; Hibbard, 1940, p. 418.

Pupilla muscorum, Goodrich, 1940, p. 77; Hibbard, 1940, p. 418.

Description of the shell: Moderately large to large in size; ovate to cylindrical-ovate; height ranging from 2.5 mm. to 3.7 mm.; rimate; suture sharply but not deeply incised; whorls 5 to 6½, convex but not inflated; 1½ nuclear whorls, finely granular; remaining whorls finely and irregularly striate, gradually and slowly increasing in size; body whorl less than half of total height of shell, contracted at the base and expanding toward the aperture; crest paralleling the peristome, large, rounded; groove immediately behind the peristome, deep; aperture triangularly oval, slightly oblique; denticles 3: an elongate and high parietal lamella, a prominent, tubercular basal fold, a prominent and inwardly ascending columellar lamella; peristome abruptly reflected, margin sharp, terminations approaching and continuous over the ultimate whorl by a thin callus.

Pupilla blandi is characterized by 3 prominent denticles while *P. muscorum* is edentulous or has low tubercular denticles.

Variations: The folds and lamellae vary in degree of prominence, remaining, however, larger than those occurring in *P. muscorum*. The number of denticles varies, the following combinations occur:

(a) a parietal lamella, a basal fold, a columellar lamella; (b) a low but elongate parietal and a low columellar lamella; (c) an elongate parietal lamella and a palatal fold; (d) a prominent, elongate parietal lamella and a prominent basal fold. Since the denticles of *Pupilla muscorum* are low and tubercular when present, shells with a reduced number of, but prominent, narrow and elongate denticles are referred to *Pupilla blandi*. The variation in height of the shell is about 1.2 mm. Elongate, as well as the shorter individuals vary in shape from ovate to cylindrically-ovate.

Although *Pupilla muscorum* and *P. blandi* differ essentially in the number and prominence of the denticles, not all of the shells of the genus *Pupilla* from the Kansas Pleistocene can be satisfactorily placed into one or the other of the two categories. Shells lacking one of the three denticles, may have two denticles which are larger than the low, tubercular denticles of *P. muscorum*. Because of the reduced number of folds and lamellae, these individuals are not typical *P. blandi*. In some instances the parietal lamella is greatly elongate, but very low. This feature is not characteristic of either species. These variables are not restricted to shells from any one locality or region, but occur among shells from several localities.

Some of the shells of the genus *Pupilla* of the Pyle Ranch, Cudahy, and Tobin faunules are edentulous which is characteristic of *P. muscorum*. Other shells have a low but long parietal lamella while others have an elongate but very low parietal lamella and a basal fold. The absence of denticles or reduced number of denticles would suggest that these shells should be referable to *P. muscorum*, but the elongate parietal lamella is suggestive of *P. blandi*.

Until a more careful study can be made of *P. muscorum* and *P. blandi* from several locations and compared with the Kansas shells, the final classification of some of the Kansas *Pupilla* remains enigmatical.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
2.5	1.1	0.9	0.9	5
2.7	1.7	1.0	1.0	5½
3.1	1.7	1.1	1.0	5½
3.3	1.9	1.1	1.1	6½
3.6	1.8	1.17	1.0	6½

Habitat: A shell of cool, humid situations. It has completely receded from Kansas.

Distribution:

Type locality: Ft. Berthold, North Dakota.

General Distribution: Rocky Mountain Region. From Alberta and Montana south to New Mexico. Mainly as a fossil and in river drift in North Dakota, South Dakota, Kansas and Texas. (Pilsbry, 1921, Vol. 26, pt. 103, pp. 159-160.) Pleistocene in Nebraska.

Distribution in Kansas:

Pleistocene: Sanborn Formation: Sherman County: 15 mi. S. of Goodland. Decatur County: 1.4 mi. E. of Dresden; 8.6 mi. E. of Oberlin; 14 mi. S. of Oberlin. Norton County: 13 mi. S, 10 mi. E. of Norton; 3 mi. S, 5½ mi. W. of Norton. Logan County: 8.5 mi. S. of Oakley. Thomas County: 1½ mi. W. of Brewster; 3 mi. S, 3½ mi. W. of Mingo; 6 mi. S, 3½ mi. E. of Colby. Sheridan County: 2½ mi. W. of Seldon; 5½ mi. W, ½ mi. S. of Seldon; 3 mi. S, 8 mi. W. of Seldon; 4 mi. W. of Seldon. Graham County: 15 mi. N. of Wakeeney. Phillips County: Long Island. Meade County, Locality number 13, (Hibbard, 1940, p. 417), Jones Sink, S 8, T 33 S, R 27 W, 5 mi. S, 3½ mi. E. of Meade; XI Ranch, S 33, T 34 S, R 29 W, 15 mi. S, 7 mi. W. of Meade. Drift in stream, 3 mi. W. of Deer Park, Meade County State Park; ravine W. of Meade County State Park. Clark County, Taylor Ranch, 9 mi. E, 1 mi. S. of Minneola.

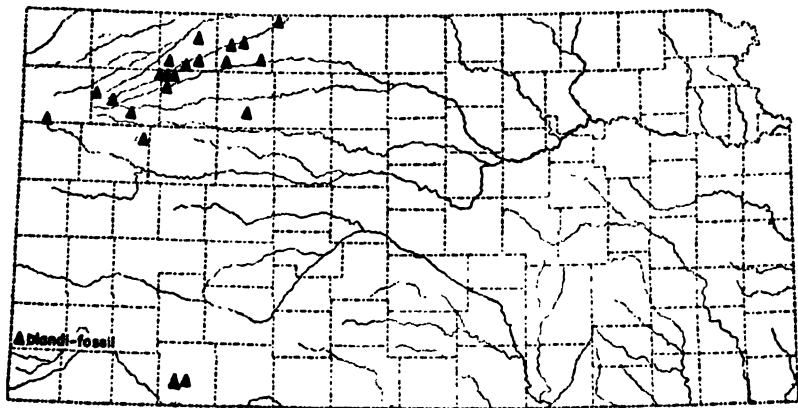


FIG. 14. Records of *Pupilla blandi* Morse.

Genus *Columella* Westerlund

"*Sphyradium* (Agass.) Charpentier, *Fauna Palaëarktischen Region Binnenconchylien* III, 1887, p. 125.—Sterki, *Nautilus*, X, 1896, p. 75.—Hanna, *Proc. U. S. Nat. Mus.*, vol. 41, p. 871 (monograph, anatomy); and of most recent American and European authors. Not *Sphyradium* as limited by von Martens, 1860.

Paludinella Lowe, *P. Z. S.* 1854, p. 208, type *P. edentula* Draparnaud. Not *Paludinella* Pfeiffer, 1861.—*Paludellina* Tyron, *Struct. and Syst. Conch.*, III, 1884, p. 72, error for *Paludinella*.

Edentulina Clessin, *Deutsche Excursions-Mollusken-Fauna*, 1876, p. 208, for *Pupa inornata* = *P. edentula* Draparnaud. Not *Edentulina* Pfeiffer, 1865 (*Streptaxidae*).

Columella Westerlund, *Fauna Europaea Moll. Extramar. Prodrum*, fasc. II, p. 198, 1878, type *Pupa* "*inornata* Mich." = *edentula* Draparnaud, Pilsbry, *Nautilus*, XXVI, 1912, p. 60.—H. Watson, *Proc. Malac. Soc. Lond.*, XV, 1923, p. 275 (anatomy)." (Pilsbry, 1926, Vol. 27, Pt. 108, p. 232.) Pilsbry, 1926, Vol. 27, Pt. 108, pp. 232-248, Plates 30, 31, figs. 1-9. Pilsbry, 1934, Vol. 28, Pt. 111, p. 109, Pl. 22, fig. 1.

Characteristics of the shell: Shell large, elongate, cylindrical, summit convex; height ranging from 2.7 mm. to 5.8 mm.; number of whorls, $6\frac{1}{2}$ to 9, finely and irregularly striate, compressed, slowly increasing in size; distinctly and roundly perforate; edentulous to tridentate: angular and parietal lamellae, if present, partially fused; columellar lamella, if present, rounded and deeply immersed; crest behind the peristome wanting.

Distribution:

Recent: Atlantic Islands, Europe, Asia, North America, Hawaii (?).

(Pilsbry, 1926, Vol. 27, pt. 108, p. 234.)

Pleistocene: Europe and the United States.

Upper Pliocene: England. (Pilsbry, 1926, Vol. 27, pt. 108, p. 234.)

KEY TO SPECIES

1. Aperture edentulous 2
Aperture not edentulous. Three denticles within the aperture.....*C. tridentata*
2. Shell exceeding 5 mm. in height.....*C. hasta*
Shell not exceeding 3 mm. in height.....*C. alticola*

Columella tridentata Leonard

Plate XXII, fig. 6. Text figure 15.

Columella tridentata Leonard, 1946, pp. 20-21.

Description of shell: "Shell large for the genus, subcylindrical, with $7\frac{1}{2}$ compressed whorls; suture well impressed; umbilicus round, small, diameter only $\frac{1}{8}$ diameter of body whorl; first 3 whorls enlarging rapidly, producing bluntly conic apex; remaining whorls increasing in size slowly but regularly; first $1\frac{1}{2}$ whorls with finely granular sculpture, remaining whorls embellished with fine, diagonal, closely spaced growth lines; last half of body whorl compressed around axis, subangulate below; aperture small, subtriangular; peristome simple, continuous by thin callus across body whorl; lip relatively heavy (broken?); lamellae 3; angular, bluntly triangular, arising near angular lip of peristome and extending downward, curving slightly toward periphery; fused with parietal lamella except near termination, which is situated midway along peripheral border of parietal; parietal lamella deeply immersed, thick, heavy, broadly spatulate, rounded; columellar lamella compressed, rounded, its long axis vertical; inner surfaces of peristome, including lamella, finely punctate." (Leonard, 1946.)

Variations: Known only from the type.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	5.2	2.52	1.5	1.44	$7\frac{1}{2}$

Habitat: Known only from the Lower Pleistocene in Kansas. Other species of the genus live in cool, humid regions.

Distribution:

Type locality: Pleistocene, Meade Formation: Tobin faunule, Russell County, Kansas, S 35, T 14 S, R 11 W, 5 mi. S, 18 mi. E of Russell.

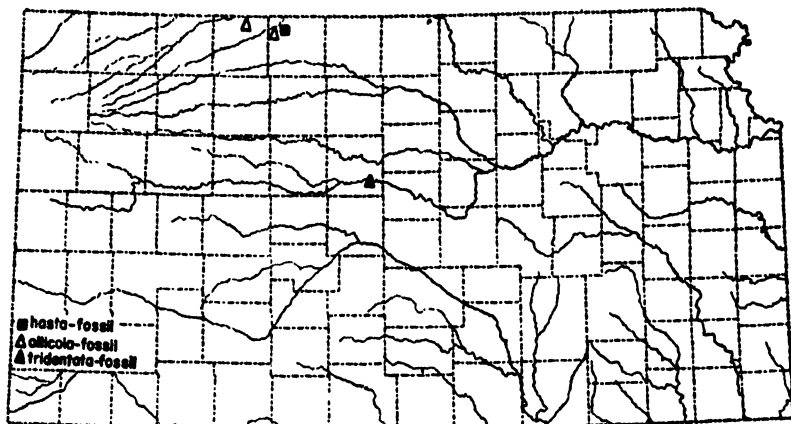


FIG. 15. Records of *Columella tridentata* Leonard, *C. alticola* (Ingersoll), and *C. hasta* (Hanna).

Columella alticola (Ingersoll)

Plate XXII, fig. 3. Text figure 15.

Pupilla alticola Ingersoll, 1875, p. 128.

Sphyradium alticolum, Hanna, 1911, pp. 373-374, fig. 2; Hanna and Johnston, 1918, pp. 115, 118, fig. 6.

Columella alticola, Henderson, 1924, p. 140, fig. 43; Pilsbry, 1926, Vol. 27, pt. 108, pp. 243-245, Pl. 31, figs. 6, 7, 8.

Description of the shell: Moderate in size for the genus; perforate, cylindrical; summit convex; height varying from 2.7 mm. to 3.0 mm. $1\frac{1}{2}$ nuclear whorls, white, finely granular; remaining whorls finely and irregularly striate; whorls $6\frac{1}{2}$ —7, convex, very slowly and regularly increasing in size to the large and inflated ultimate whorl which is without crest or callus; aperture oval, oblique, edentulous, without a callus; peristome simple, reflected on columellar side; margin sharp.

Variations: Since the shells occurring in Kansas are fossils, their coloration is white or pale auburn with a white nucleus. The only other variant is the total height of the shell which ranges from 2.7 mm. to 3.0 mm.

MEASUREMENTS

Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
3.0	1.35	0.7	0.6	6¼
2.9	1.3	0.7	0.6	6¼
2.8	1.35	0.8	0.7	6½
2.7	1.2	0.7	0.6	6½

Habitat: *Columella alticola* is known from Kansas only from the Sanborn formation, Upper Pleistocene in age. Its present day distribution includes northern areas or areas of high altitudes of New Mexico, Colorado, Utah, and Wyoming which indicates that in the time of its existence in Kansas, the temperature was lower and the humidity higher than obtains in northwestern Kansas at the present time.

Distribution:

Type locality: Cunningham Gulch, Colorado.

General distribution: Alberta and British Columbia; mountainous regions of New Mexico, Arizona, Colorado and Wyoming. (Pilsbry, 1926, Vol. 27, pt. 108, p. 244.) Pleistocene in Kansas and Nebraska.

Distribution in Kansas: Sanborn Formation: Phillips County, Long Island; Norton County, SE¼, S 5, T 1 S, R 22 W, 10½ mi. N, 4 mi. E of Norton.

Columella alticola is extinct from Kansas probably because it is intolerant of high temperatures and low precipitation which characterize the prolonged summer season. Its occurrence in the Pleistocene beds indicates that in the time the Sanborn deposits were laid down, climatic conditions differed from those of the present time. The temperature must have been lower and the amount of annual precipitation higher than at the present time, or the precipitation more equitably distributed.

Columella hasta (Hanna)

Plate XXII, fig. 5. Text figure 15.

Sphyradium hasta Hanna, 1911, pp. 372-373; Hanna and Johnston, 1913, pp. 115, 118.
Columella hasta, Pilsbry, 1926, Vol. 27, pt. 108, pp. 245-246, Pl. 30, fig. 13.

Description of the shell: "Shell more than 5 mm. in height, long and cylindrical. Light brown in color and glossy. Spire greatly elevated but obtusely pointed on the apex. Whorls 8½-9, rather flattened on the face and the last subangulated around the periphery. The last six whorls are of about equal diameter; the first three increase rapidly. Lines of growth faint and oblique; apex smooth and white. Aperture somewhat angulated at the base of the columella. Peristome thin and acute, forming a regular curve without an in-

dentation in the upper palatal region, such as is present in most of the *Vertigos*. The aperture is very slightly thickened by a callus on the inside of the peristome in the basal region. Peristome not reflected and with no callus back of the aperture. Teeth and lamellae entirely absent from the aperture. Umbilicus with a very small perforation. Length 5.81 mm.; diameter, 2.03 mm. This species differs from all others of *Sphyradium* [*Columella*] by its much greater size and the relatively smaller aperture." Hanna, 1911, pp. 372-373.

Variations: Hanna (1911, p. 373) speaks of a series of specimens of *Columella hasta* collected by Edward C. Johnston and G. Dallas Hanna. However, only the holotype was available for this study and no record of the paratypes could be found. Therefore, no comparisons with paratypes nor with other individuals could be made.

MEASUREMENTS

	Total height, mm.	Greatest diameter, mm.	Height of aperture, mm.	Width of aperture, mm.	Number of whorls
Holotype:	5.81	2.03	1.35	1.2	8½

Habitat: *Columella hasta* is known only from the type locality. Since *Columella alticola* and many other pupillids represented in the fauna of the Pleistocene, northwestern Kansas, are restricted in their recent distribution to regions where cooler climatic conditions obtain, a reasonable conjecture is that *C. hasta* likewise preferred a cool, moist habitat.

Distribution:

Type locality: Pleistocene of Long Island, Phillips County, Kansas.

Distribution in Kansas: Known only from the type locality.

DISCUSSION

The family Pupillidae is represented in Kansas and in the Lower Pliocene of northern Oklahoma by 33 species and subspecies, fossil and Recent, belonging to 5 genera. The predominating genus, *Gastrocopta*, is known by 14 fossil and living species and subspecies, *G. proarmifera*, *armifera*, *contracta*, *falcis*, *holzingeri*, *tappaniana*, *rexroadensis*, *corticaria*, *procera*, *cristata*, *paracristata*, *riograndensis*, *pellucida hordeacella* and *anterides*. The genus *Vertigo*, second in prominence, is represented by 10 species and subspecies, fossil and Recent, in the fauna of the region studied: *Vertigo ovata*, *V. ovata morsei*, *elatior*, *gouldi*, *gouldii paradoxa*, *tridentata*, *hannai*, *modesta*, *milium*, and *hibbardi*. Of the genus *Pupoides*, three species, fossil

and Recent are known: *P. marginatus*, *hordaceus*, and *inornatus*. Three fossil species and subspecies belong to the genus *Pupilla*: *P. muscorum*, *muscorum sinistra*, and *blandi*. Three fossil species of the genus *Columella* are known from this region: *C. alticola*, *hasta*, and *tridentata*.

Of the 33 species and subspecies of Pupillidae in the region studied, 4 are known from the Recent only. Eleven species and subspecies are known from the fossil as well as from the living fauna including *Vertigo ovata* and *Pupoides marginatus* which occur in the earliest known fauna of the region studied. Eighteen species and subspecies are known only as fossils of which 10 are extinct and 8 are extant but have receded from this region to cooler climates before or since the close of the Pleistocene.

Ecological Considerations:

The pupillid faunule of the Laverne Formation, Lower Pliocene, includes 4 species, *Gastrocopta anterides*, *G. riograndensis*, *Vertigo ovata*, and *Pupoides marginatus*. The small number of species as well as a small number of individuals of pupillids known from this formation presents only an incomplete indication of the climatic conditions and ecological situations. *Vertigo ovata* and *Pupoides marginatus* are living today, are widespread in their distribution in North America and live in timbered areas as well as in grasslands. They are, therefore, not good indicators of any specific ecological situations. *Gastrocopta anterides* is known only from the Laverne Formation. Perhaps the most significant pupillid is *Gastrocopta riograndensis* which is a southern species living today in valleys and canyons of Texas and northern central Mexico where the mean temperature is higher than in northern Oklahoma.

The total known molluscan faunule of the Laverne Formation includes 4 species of pelecypods and 21 species of gastropods. The gastropods include 16 aquatic and 5 terrestrial species (Leonard and Franzen, 1944, pp. 15-39, Plates IV, V). The occurrence of the large number of aquatic species, as well as individuals, and the occurrence of fish scales and vertebrae, and amphibian bones signifies that bodies of water were present. The bodies of water, whether large lakes, a series of small lakes, or flowing streams must have been permanent rather than ephemeral. This is indicated by the occurrence of 4 species of *Helisoma*, 2 species of *Ferrissia*, 1 species of Viviparidae, and 4 species of Amnicolidae.

Fossil plants have been recovered from the Laverne deposits. These have been studied by Chaney and Elias (1938, pp. 16-34),

who have recognized 11 species of trees of which one species, *Cercidiphyllum crenatum*, a magnolia now restricted to eastern Asia, may have belonged to the humid redwood forest, whereas the other trees are mesic species. Only one of the trees, *Sapindus drummondi* (of the Soapberry family) related to the Laverne flora remains in western Oklahoma.

The present day amount of rainfall, scarcely 20 inches, is insufficient to support a mesic floodplain forest which Chaney and Elias assume to have existed in Laverne times. Areas in eastern and central Oklahoma which support a floodplain forest consisting of species closely related to the Laverne flora, receive approximately 30 inches of rainfall annually. Chaney and Elias recognize the occurrence of buckthorn and a coffee tree in the Laverne deposits as indicative of a higher mean temperature than that of western Oklahoma today.

The occurrence of a large aquatic, molluscan fauna, including Viviparidae and Amnicolidae, associated with fish and amphibians, the presence of a southern pupillid, and the records of a floodplain forest including trees almost entirely restricted to regions of large amount of rainfall and warm temperatures, are indicative of warm and humid climatic conditions obtaining in western Oklahoma in Lower Pliocene times when the Laverne deposits were laid down.

The Saw Rock Canyon (Upper Pliocene in age, Hibbard, verbal communication, June, 1946) pupillid faunule resembles closely that of the Fox Canyon, Big Springs and Rexroad deposits which have been assigned to the Blancan age. *Gastrocopta paracristata* and *Vertigo hibbardi* occur in beds of both ages and are restricted in distribution to the Saw Rock Canyon and Blancan beds. The earliest known occurrence of *Gastrocopta tappaniana* and *Vertigo milium* living in Kansas today, is in the Saw Rock Canyon deposits but these species occur also in the Blancan beds. Associated gastropod mollusks other than pupillids also tend to show a continuity rather than a contrast of fauna. Three species of pupillids, *Gastrocopta cristata*, *rexroadensis* and *holzingeri* occur in the Blancan but apparently not in the Saw Rock Canyon deposits. This apparent absence may be due to incomplete recovery of the Saw Rock Canyon faunule rather than absence from these deposits.

Aquatic mollusks are also included in the molluscan faunule of the Saw Rock Canyon as well as in the Blancan deposits and approximate in number of species, the terrestrial species. The abundance of aquatic mollusks indicates the presence of bodies of water. The pupillids, *Gastrocopta tappaniana*, *procera*, *holzingeri*, *Vertigo*

milium and, as reported from the Rexroad Ranch deposits by Baker (in Hibbard, 1941a, p. 265), the associated terrestrial woodland species, *Retinella electrina* (Gould), *rhoadsi* Pilsbry, *wheatlyi* Bland, *Strobilops sparsicostata* F. C. Baker, are indicative of the presence of moist, wooded floodplains.

The amphibian faunule, including salamanders, frogs and toads, as known from the Rexroad Ranch deposits, is larger than that of Meade County of the present time (Taylor, 1942, p. 220). Spines of catfish and other fish remains indicate the presence of streams with permanent pools or oxbow lakes.

The known mammals include horses from grassy uplands, beaver and raccoon from lowlands near water, a shrew, a vole, a lemming, a meadow mouse, and a cotton rat from meadows and marshes, browsers such as mastodonts and deer and the woodrat from forests.

The occurrences in the Rexroad Ranch deposits of aquatic gastropods, of mammals which rely upon water for food supply, and of fish are evidence of streams flowing through southwestern Kansas in Blancan times. The abundance and varied nature of the amphibian faunule is indicative of humid conditions. Woodland gastropods and browsing mammals are evidence of the existence of timber (Hibbard, 1941a, pp. 94-102), although such ecological features as streams, meadows, and timber may well have been of local occurrence.

Temperatures were probably not much lower in winter nor higher in the summer than they are in southwestern Kansas today, a conclusion which may be reached by comparing the Rexroad Ranch fauna with that of present day Kansas. The cotton rat, *Sigmodon*, is included in the Rexroad fauna. It is a present day inhabitant of Meade County, but its known range extends only about 150 miles farther north. The present day molluscan fauna includes *Pupoides marginatus*, *Gastrocopta cristata*, *holzingeri*, *tappaniana*, *Stenotrema* sp., *Succinea grosvernori* and *Physa anatina*, all species which have been recovered from the Rexroad Ranch deposits.

The pupillids, *Pupilla muscorum*, *Vertigo gouldii*, and *V. modesta* are included in the fauna of the Meade Formation, Lower Pleistocene, of southwestern Kansas. These species are extant in North America where their range is in cool regions of Canada, northern United States and in mountainous areas. Their occurrence in the deposits of the Meade Formation indicates that somewhat lower mean temperatures obtained in Kansas in early Pleistocene times. Other terrestrial gastropods recovered from beds of the Meade For-

mation include *Cochlicopa lubrica*, essentially a northern snail, *Strobilops affinis*, a woodland snail of humid regions, and *Euconulus chersinus*, also a woodland snail. The last three snails named are included in the present-day Kansas fauna but are known to be living only in the timber of the eastern part of the state. Woodland snails widely distributed over the United States and found in deposits of the Meade Formation, include *Stenotrema monodon*, *Discus cronkhitei anthonyi* Pilsbry, and *Zonitoides arboreus* (Say). *Carychium exiguum*, a snail preferring damp places and being able to withstand very moist conditions, has also been recovered from the Meade Formation. It is found living in Kansas but only in moist and usually in wooded areas.

Aquatic species are well represented in the Lower Pleistocene of southwestern Kansas. *Menetus kansasensis* Baker, *Helisoma trivolvis* (Say), *Gyraulus parvus* (Say), *Valvata tricarinata* and species of *Lymnea* and *Physa* are included in the fauna.

The occurrence of mammals such as *Sorex*, *Microtus*, *Neosorex*, and *Microsorex* in the fauna of the Meade Formation also indicates that the climate in southwestern Kansas may have been cooler in early Pleistocene times than it is today. This is based upon the distribution of the living relatives of the above forms. They live mainly in the Boreal region although they do range into the Transition Life-zone of the Austral region. Their habitat is in humid and shaded areas (Hibbard, 1944, p. 741).

The occurrence in the deposits of the Meade Formation of terrestrial gastropod species now living in areas of cool and humid climate, an abundant aquatic gastropod faunule including northern forms, a large faunule of mammals many of whose living relatives inhabit cool and humid regions, abundance of plant remains in some localities and iron concretions indicative of local swampy conditions, are evidence of a comparatively cool and relatively more humid climate in southwestern Kansas in early Pleistocene times.

The pupillid species dominant in the Upper Pleistocene deposits in Kansas are now living or represented by closely related species in Canada, northern United States or in cool, humid mountainous regions. Those species which entered Kansas in Upper Pleistocene times are no longer represented in the Kansas fauna. One exception to this may be *Vertigo modesta*. However, the one record of *Vertigo modesta* is a dead, bleached shell which is of doubtful age.

Approximately 20,000 skeletal elements of salamanders, and also bones of frogs and toads have been recovered from Jones Ranch

beds. Fish vertebrae, spines and pharyngeal bones with teeth are also included in this fauna.

The general occurrence in the Upper Pleistocene deposits of pupillids which live today under cool and humid climatic conditions, an abundant molluscan faunule, a large number of amphibians, especially salamanders, the occurrence of mammals occupying meadows and timber and living in humid environments are indications of a cool and humid climate in the Upper Pleistocene of Kansas.

The climate of Kansas today is characterized by periodic rains, prolonged dry, hot summers and mild to cold winters. The weather is subject to sudden changes. The species of pupillids living here are those one would expect to find under prevailing climatic conditions. The species represented in the Pleistocene which are restricted in range to cool and humid climates have receded to cooler regions. The species which have remained are either tolerant of the present day conditions or are limited in distribution to isolated areas where humid conditions obtain. Southern species, *Gastrocopta corticaria* and *Gastrocopta pellucida hordeacella* have invaded Kansas apparently since Pleistocene times.

Certain pupillids such as *Gastrocopta cristata* and *G. procera* live in timbered areas in various parts of the state. Some of the woodland snails other than pupillid species which are found in timber, such as *Cochlicopa lubrica* and the genera *Strobilops* and *Eucornulus* are also known from the deposits of the Meade Formation in southwestern Kansas. Today these snails are restricted in Kansas to the timbered areas of the eastern part of the state.

Faunal Succession:

Several significant faunal discontinuities are evident in the vertical distribution of pupillids, Lower Pliocene to Recent, in Kansas and Beaver County, Oklahoma. Although there is a continuity in the fauna of certain pupillids which, according to wide extent of their present range, are tolerant of varied climatic situations, there are certain very evident faunal changes indicating climatic changes between the several deposits under consideration. (See Table I.)

The known pupillid faunule of the Laverne Formation, Beaver County, Oklahoma, is meager. Of the four pupillid species known, two species, belonging to two genera, *Vertigo ovata* and *Pupoides marginatus* are extant in Kansas, one species, *Gastrocopta anterides*, is extinct, and one species, *Gastrocopta riograndensis* is living only in southern states and is not known to occur either in the Pleistocene or in the Recent fauna of Kansas.

Pupillids are not known from deposits of the Middle Pliocene in Oklahoma and Kansas; thus there is a gap in the faunal sequence. The molluscan faunule of the Laverne Formation contrasts markedly with that of the Saw Rock Canyon deposits, presumably of Upper Pliocene age, and the beds assigned to the Blancan age as may be seen by noting the absence of *G. anterides* and *G. riograndensis* from the succeeding horizons and the consequent introduction of other species.

The continuity of the pupillid faunule from the Saw Rock Canyon deposits through those of Blancan age is certainly more conspicuous than any trend toward discontinuity. Five of the 6 pupillids known from the Saw Rock Canyon faunule occur in the Blancan beds. *Gastrocopta procera* occurs in the Saw Rock Canyon deposits, is not known from the Blancan deposits, but is continuous in occurrence from Lower Pleistocene to Recent times. This species will probably be recovered from the Blancan beds when more intensive studies are made. Of the eight pupillids recovered from the beds of Blancan age, 5 occur also in the Saw Rock Canyon deposits. Among the 5 species common to the Saw Rock Canyon deposits and the Blancan beds are *Vertigo hibbardi* F. C. Baker and *Gastrocopta paracristata*. This is significant because these two species are abundant but limited in vertical distribution to these deposits. *Gastrocopta tappaniana* occurs uninterruptedly from Saw Rock Canyon deposits to the Recent time. *Vertigo milium*, a pupillid of the Saw Rock Canyon deposits and of a Blancan deposit, is known to occur in the Lower Pleistocene and Recent fauna of Kansas. *Pupoides marginatus*, common to the Saw Rock Canyon and the Blancan deposits is not known from the Lower Pleistocene beds, possibly because of insufficient collecting, but is abundant in the Upper Pleistocene and Recent faunas.

Although there is not a complete break in the molluscan faunule between the beds of Blancan age and the beds of Lower Pleistocene age, represented here by the Meade Formation, some very significant faunal changes take place. *Gastrocopta paracristata*, an abundant fossil species, *Vertigo hibbardi*, the dominant species of the genus of its time and *G. rexroadensis* are not known to occur above the deposits assigned to the Blancan. Another pronounced change in the molluscan faunule is that of the appearance for the first time in Kansas of the genera *Pupilla* and *Columella* and of the species *Vertigo gouldii*, *Gastrocopta contracta* and the *Gastrocopta armifera* series as introduced by *Gastrocopta proarmifera*. *Gastrocopta falcis*

is a species known from only two localities of the Meade Formation. (See Table I.)

The species which persist through the Middle Pleistocene times are those whose vertical range extends from the Laverne and the Blancan to the present time. Those species include *V. ovata*, *Pupoides marginatus*, *G. tappaniana* and *G. procera*.

A significant pupillid faunal discontinuity occurs between the Lower and Upper Pleistocene horizons. However, the break is not as profound as it is between the Blancan and the Lower Pleistocene. This break is characterized mainly by the introduction of species and an increase in prominence of certain species rather than by a termination of many species. Three species of the Lower Pleistocene, *Vertigo gouldii*, *Gastrocopta falcis* and *G. proarmifera* are not found in the beds of the Upper Pleistocene. *G. proarmifera* is succeeded by a closely related species, *G. armifera*. *V. gouldii* is replaced by the subspecies *Vertigo gouldii paradoxa*. *V. elatior*, *V. modesta*, *C. hasta*, *C. alticola* and *Pupilla blandi* are known for the first time in Kansas in the Upper Pleistocene.

There is a marked contrast between the Pleistocene and the Recent pupillid faunule. The species *V. tridentata*, *V. modesta*, *V. g. paradoxa*, *Pupilla muscorum*, *Pupilla blandi*, and *C. alticola*, whose Recent range is restricted to cool and humid climates, have receded, while *V. hannai* and *C. hasta* have become extinct. A few southern snails, *G. pellucida hordeacella* and *G. corticaria*, have come in from the south. If the shell of *Pupoides inornatus*, which was probably taken from drift, indicates that this species is a Kansas resident, then a western form has entered Kansas. The validity of the Recent record of the eastern form, *Vertigo modesta*, is doubtful.

The predominant living pupillids are those which have been residents of Kansas since Blancan, Lower Pliocene or Upper Pleistocene times. These species include *V. ovata*, *V. milium*, which are distributed sporadically and are probably remnant forms, *Pupoides marginatus* and *Gastrocopta armifera* which are tolerant of varied climatic conditions and are ubiquitous in Kansas today, and *G. cristata*, *G. procera* and *G. tappaniana* which also are tolerant of varied climatic conditions. The predominant pupillids of the present day molluscan faunule are *Gastrocopta armifera* and *Pupoides marginatus*.

CONCLUSIONS

The purposes of this study have been to make a taxonomic study and a vertical as well as horizontal distributional study of the pupillids as found in the Lower Pliocene of northwestern Oklahoma, Lower Pleistocene to Recent in Kansas, and Pleistocene of Nebraska.

In proceeding with the taxonomic study, the authors studied carefully the shells of pupillids in the collection of the Museum of Natural History, University of Kansas, and a series of unidentified Pleistocene shells loaned by the State Museum, University of Nebraska. The classifications of shells previously identified as well as those identified by the authors were carefully compared with the shells of the collections of the Museum of Zoölogy, University of Michigan, Ann Arbor; The United States National Museum, Washington; The Academy of Natural Sciences of Philadelphia; and the Carnegie Museum, Pittsburgh, Pennsylvania.

At various times, *Gastrocoutha procera* and the subspecies, *G. p. sterkiana* and *G. p. mcclungi* have been reported as occurring in Kansas. The authors made a study of shells assigned to these named kinds and studied also their geographical distribution within Kansas. As a result it was found that the shells assigned to these three forms occurred within the same populations over all of the region considered and that the characters of the shells formed a continuous intergrading series within a population. Therefore, the pupillids of Kansas previously assigned to the subspecies *G. p. sterkiana* and the previously known subspecies described from Kansas, *G. p. mcclungi*, are here considered as synonymous with *G. procera*.

A similar study was made of the shells collected in Kansas, which have been assigned to the species *Gastrocoutha armifera* and its several subspecies. The shells assigned to the several subspecies are not limited geographically in their distribution and the characters of the several "subspecies" intergrade within a population. Therefore, the shells occurring in Kansas and previously assigned to the several subspecies of *G. armifera* are here referred only to *G. armifera*.

Vertigo hannai Pilsbry was originally described as *Vertigo martini* Hanna and Johnston. This species is distinct and valid. However, in the description of the holotype an error was made in describing the columellar lamella. The senior author recently examined the holotype at The United States National Museum, Catalogue number

226396, and consequently made corrections in the definition of the species.

Two new fossil species belonging to the genus *Gastrocopta* are described. *Gastrocopta paracristata* occurs in the Saw Rock Canyon deposit, Upper Pliocene (?), and in beds assigned to the Blancan age. *Gastrocopta rexbroadensis* is known from deposits assigned to the Blancan age.

Previously certain shells from Kansas have been referred to the species *Pupilla hebes*. This identification is an error. The species *Pupilla hebes* does not occur in Kansas either in the fossil or in the living faunas.

Certain shells have previously been identified as *Vertigo coloradensis*. This is also an error. *V. coloradensis* is not known from collections of fossil or living shells from the area studied.

A study of the vertical distribution reveals a faunal break between the pupillid faunules of the Laverne Formation, Lower Pliocene, and of the Saw Rock Canyon, supposedly Upper Pliocene in age. The pupillid faunule of the Saw Rock Canyon closely resembles the faunule occurring in the beds referred to the Blancan age. The differences between the two faunules are much less pronounced than are the similarities. A very pronounced faunal break is evident between the pupillids of the Blancan deposits and those of the Meade Formation. A significant, though not profound, faunal break occurs between the Lower Pleistocene and the Upper Pleistocene pupillid faunules. The contrast between the Upper Pleistocene and the Recent pupillids is mainly the result of a recession of several forms and the invasion of a few species since Pleistocene times.

Faunal discontinuities are one indication of climatic change. The pupillid faunules of the several ages are indicative of the prevalence of certain climates. The four pupillid species known from the Laverne Formation indicate a warm, humid climate. The pupillids of the Saw Rock Canyon and of the Blancan faunas are associated with a cool, humid climate. The pupillids of the Lower and the Upper Pleistocene faunas also prefer cool and humid conditions. The species formerly resident in the state, but now known to be living only in cool and humid regions are not included in the present day Kansas fauna. A few pupillids from warmer regions have entered Kansas. The predominating species are those which are tolerant of a cool to warm, and humid to dry climate.

Two pupillids which lived in this region in Lower Pliocene times, three species which are first known from the Saw Rock Canyon

deposits, two species first occurring in the Blancan deposits, one species first appearing in the Lower Pleistocene still remain in the Recent fauna of this region.

The pupillids of Kansas and of the adjoining areas included in this study, do not present a study of evolutionary progression. The characters of the shells of *Vertigo ovata* and of *Pupoides marginatus* as known from the Laverne Formation do not differ from those of the Pleistocene deposits or from those of the Recent fauna. *Vertigo milium* is also an example of this conservatism. The shells of this species occurring in the Saw Rock Canyon deposits do not differ from those of *Vertigo milium* living in Kansas at the present time. *Gastrocopta tappaniana* and *G. holzingeri* also have not undergone any changes since Lower Pleistocene time.

The study of the pupillids represented in the fossil and the living faunas is of value in determining probable climatic and ecological conditions in various geological ages. The faunal assemblages and faunal breaks are significant. The pupillids tolerant only of a warm climate do not occur with those species limited in range to areas of cool climates. The faunal breaks between the two geologic horizons having similar climates, such as the Lower and the Upper Pleistocene, indicates a long interval in which adverse conditions prevailed.

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SPECIES	LAVERNE FORMATION	RAIL ROCK CANYON	FOX CANYON	BIG SPRINGS RANCH	REINOLD RANCH	SUNSHINE	CUDANY	WILSON VALLEY	TOBIN	FILE RANCH	RANDON FORMATION	REZARK	HI-RANCH	JONES QUARRY	TAYLOR RANCH	UPPER RANCH	NECENT	VERTICAL DISTRIBUTION
GASTROCOPTA PROARMIFERA											O		T	O				
GASTROCOPTA ARMIFERA															O		O	O
GASTROCOPTA CONTRACTA												O			O			O
GASTROCOPTA FALCIS										T				O				
GASTROCOPTA HOLINGERI								O							O			O
GASTROCOPTA TAPPANIANA				O	O	O						O	O	O		O		O
GASTROCOPTA REXROADENSIS					O	O	T											
GASTROCOPTA CORTICARIA																		O
GASTROCOPTA PROCERA				O								O	O		O	O		O
GASTROCOPTA CRISTATA						O	O	O								O	O	O
GASTROCOPTA PARACRISTATA				O	T		O											
GASTROCOPTA RIOGRANDENSIS		O																
GASTROCOPTA P. HORDEACELLA																		O
GASTROCOPTA ANTERIDES		T																
VERTIGO O. MORSEI											O							
VERTIGO OVATA		O								O	O					O	O	O
VERTIGO ELATIOR															O			
VERTIGO GOULDII											O	O						
VERTIGO O. PARADOXA															O			
VERTIGO TRIDENTATA																		O
VERTIGO HANNAI															T			
VERTIGO MODESTA															O			O
VERTIGO MILIUM				O				O		O	O							O
VERTIGO HIBBARDI				O			O	T										
PUPOIDES MARGINATUS		O	O	O	O	O	O								O		O	O
PUPOIDES HORDAGEUS																	O	O
PUPOIDES INORNATUS								O										O
PUPILLA MUSCORUM												O			O			
PUPILLA M. SINISTRA											O		O	T				
PUPILLA BLANDI															O		O	O
COLUMELLA TRIDENTATA														T				
COLUMELLA ALTIGOLA															O			
COLUMELLA HASTA																T		

T-type locality O-records of occurrence

TABLE 1. Vertical distribution of *Pupillidae* in Kansas.

PLATE XVII

EXPLANATION OF FIGURES

- FIG. 1—*Gastrocopta proarmifera* Leonard.
Catalogue number 3710, p. 23.
- FIG. 2—*Gastrocopta proarmifera* Leonard.
Catalogue number 3710, p. 23.
Dissected view to show the columellar lamella.
- FIG. 3—*Gastrocopta armifera* (Say).
Catalogue number 3489, p. 25.
- FIG. 4—*Gastrocopta armifera* (Say).
Catalogue number 3489, p. 25.
Dissected view to show the columellar lamella.
- FIG. 5—*Gastrocopta armifera* (Say).
Catalogue number 3489, p. 25.
Dissected view to show the columellar lamella.

All figures $\times 18$

All catalogue numbers are those in the molluscan collection in the Kansas University Museum of Natural History.

PLATE XVII

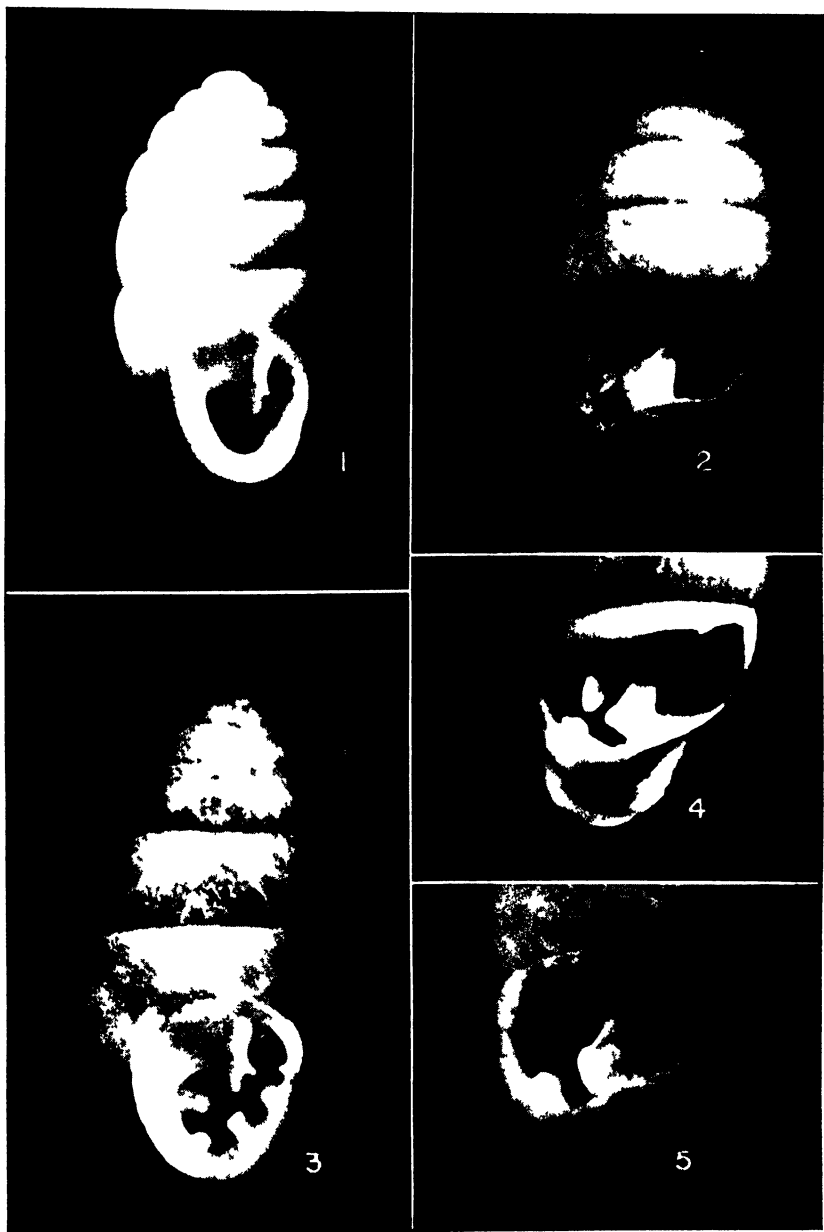


PLATE XVIII

EXPLANATION OF FIGURES

- FIG. 1—*Gastrocopta falcis* Leonard.
Catalogue number 3729, p. 35.
- FIG. 2—*Gastrocopta holzingeri* Sterki.
Catalogue number 2281, p. 41.
- FIG. 3—*Gastrocopta procer*a (Gould).
Catalogue number 59, p. 52.
- FIG. 4—*Gastrocopta rorroadensis* Franzen.
Catalogue number 3764, Paratype. p. 46.
- FIG. 5—*Gastrocopta rorroadensis* Franzen.
Catalogue number 3764, p. 46.
Dissected view showing angular, parietal, and columellar lamellae.
- FIG. 6—*Gastrocopta procer*a (Gould).
Catalogue number 3797, p. 52.
Showing labial callus.
- FIG. 7—*Gastrocopta corticana* (Say).
Catalogue number 2062, p. 49.
- FIG. 8 *Gastrocopta tappaniana* (C. B. Adams).
Catalogue number 398, p. 42.
- FIG. 9—*Gastrocopta contracta* (Say).
Catalogue number 1029, p. 30.

All figures $\times 18$

All catalogue numbers are those in the molluscan collection in the Kansas University Museum of Natural History.

PLATE XVIII



PLATE XIX

EXPLANATION OF FIGURES

- FIG. 1—*Gastrocopta cristata* (Pilsbry and Vanatta)
Catalogue number 3794, p. 59.
Showing labial callus.
- FIG. 2—*Gastrocopta paracristata* Franzen.
Catalogue number 3929, Holotype, p. 63.
- FIG. 3—*Gastrocopta paracristata* Franzen.
Dissected view showing columellar lamella.
- FIG. 4—*Vertigo marsei* Sterki.
Catalogue number 3704, p. 78.
- FIG. 5—*Vertigo marsei* Sterki.
Catalogue number 3704, Transitional, p. 78.
- FIG. 6—*Vertigo ovata* Say.
Catalogue number 56, p. 83.
- FIG. 7—*Gastrocopta riograndensis* (Sterki).
Catalogue number 1003, p. 67.
- FIG. 8—*Gastrocopta pallucida hordeacella* (Pilsbry).
Catalogue number 2085, p. 70.
- FIG. 9—*Gastrocopta antirides* Leonard and Franzen.
Catalogue number 1002, Holotype, p. 73.

All figures $\times 18$

All catalogue numbers are those in the molluscan collection in the Kansas University Museum of Natural History.

PLATE XIX

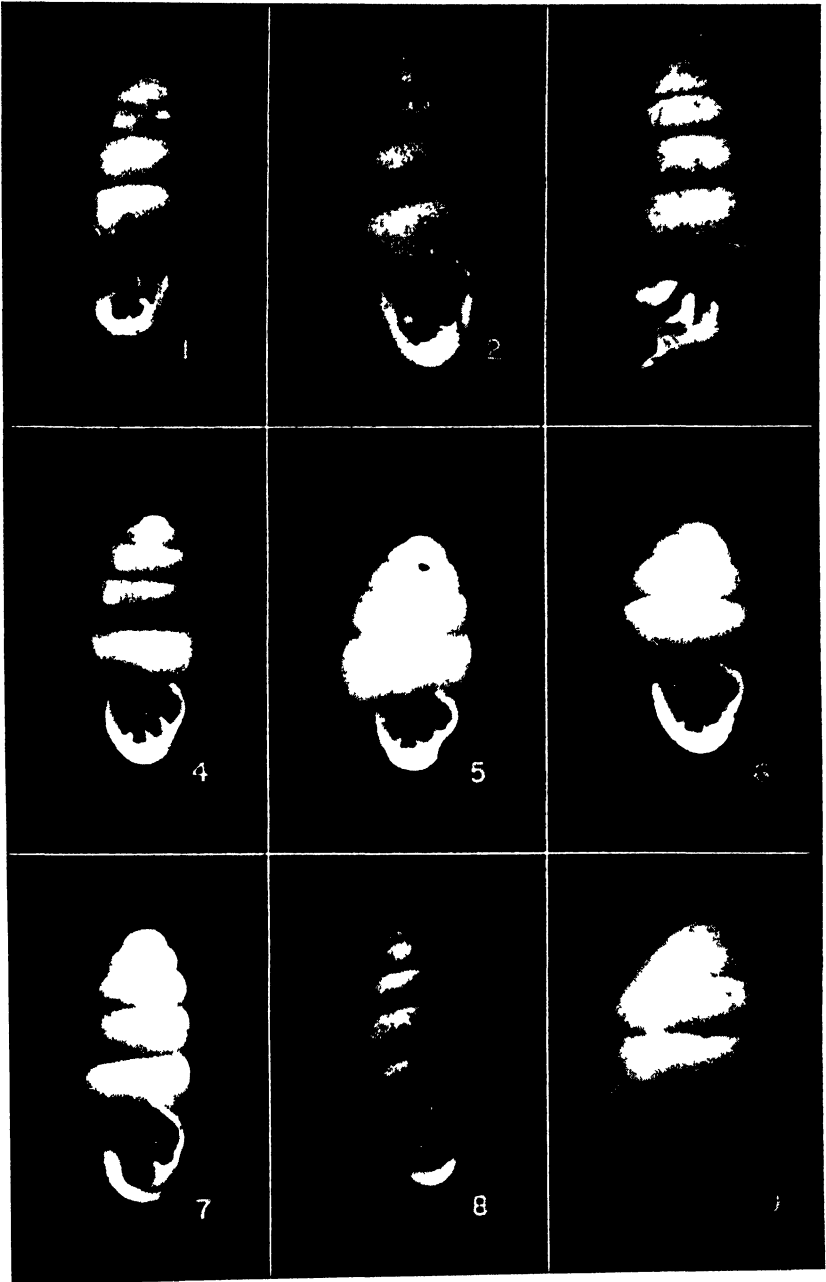


PLATE XX

EXPLANATION OF FIGURES

FIG. 1—*Gastrocopta cristata* (Pilsbry and Vanatta).

Catalogue number 82, p. 59.

FIG. 2—*Vertigo elatior* Sterki.

Catalogue number 3608, p. 88.

FIG. 3—*Vertigo gouldii* (Binney).

Catalogue number 404, p. 91.

FIG. 4—*Vertigo gouldii paradoxa* Sterki.

Catalogue number 3822 p. 94.

FIG. 5—*Vertigo tudentata* Wolf.

Catalogue number 2668, p. 98.

FIG. 6—*Vertigo modesta* (Say).

Catalogue number 3615, p. 104.

FIG. 7—*Vertigo hannai* Pilsbry.

Catalogue number 2647, p. 101.

FIG. 8—*Vertigo milium*.

Catalogue number 2648, p. 108.

FIG. 9—*Vertigo hubbardi* F. C. Baker.

Catalogue number 3754, p. 112.

FIG. 10—*Vertigo hubbardi* F. C. Baker.

Dissected view showing angular, parietal and columellar lamellae.

All figures $\times 18$

All catalogue numbers are those in the molluscan collection in the Kansas University Museum of Natural History.

PLATE XX

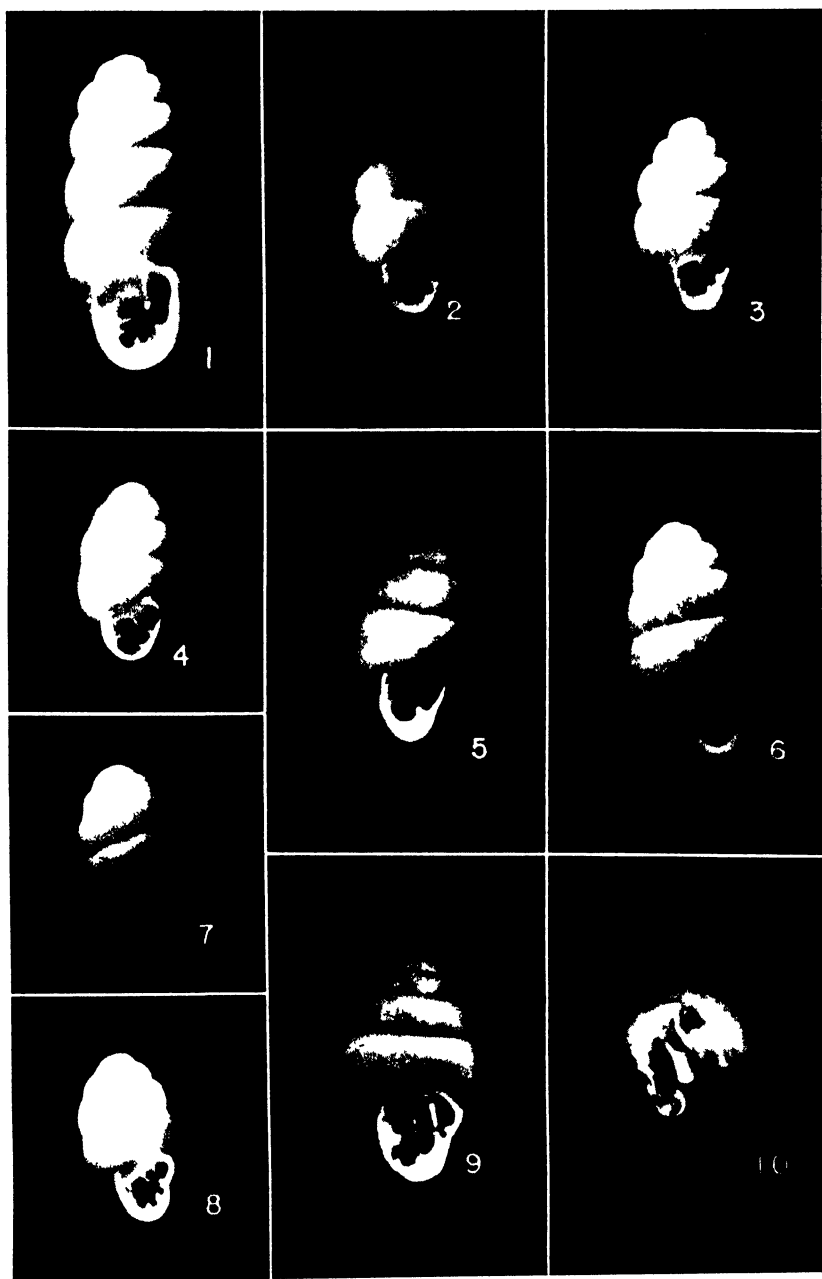


PLATE XXI

EXPLANATION OF FIGURES

- FIG. 1—*Pupoides inornatus* Vanatta.
Catalogue number 2374, p. 126.
- FIG. 2—*Pupoides hordacens* (Gabb).
Catalogue number 2083, p. 122.
- FIG. 3—*Pupoides marginatus* (Say).
Catalogue number 1037, p. 118.
Showing a very widely reflected lip.
- FIG. 4—*Pupoides marginatus* (Say).
Catalogue number 157, p. 118.

All figures $\times 18$

All catalogue numbers are those in the molluscan collection in the Kansas University Museum of Natural History.

PLATE XXI

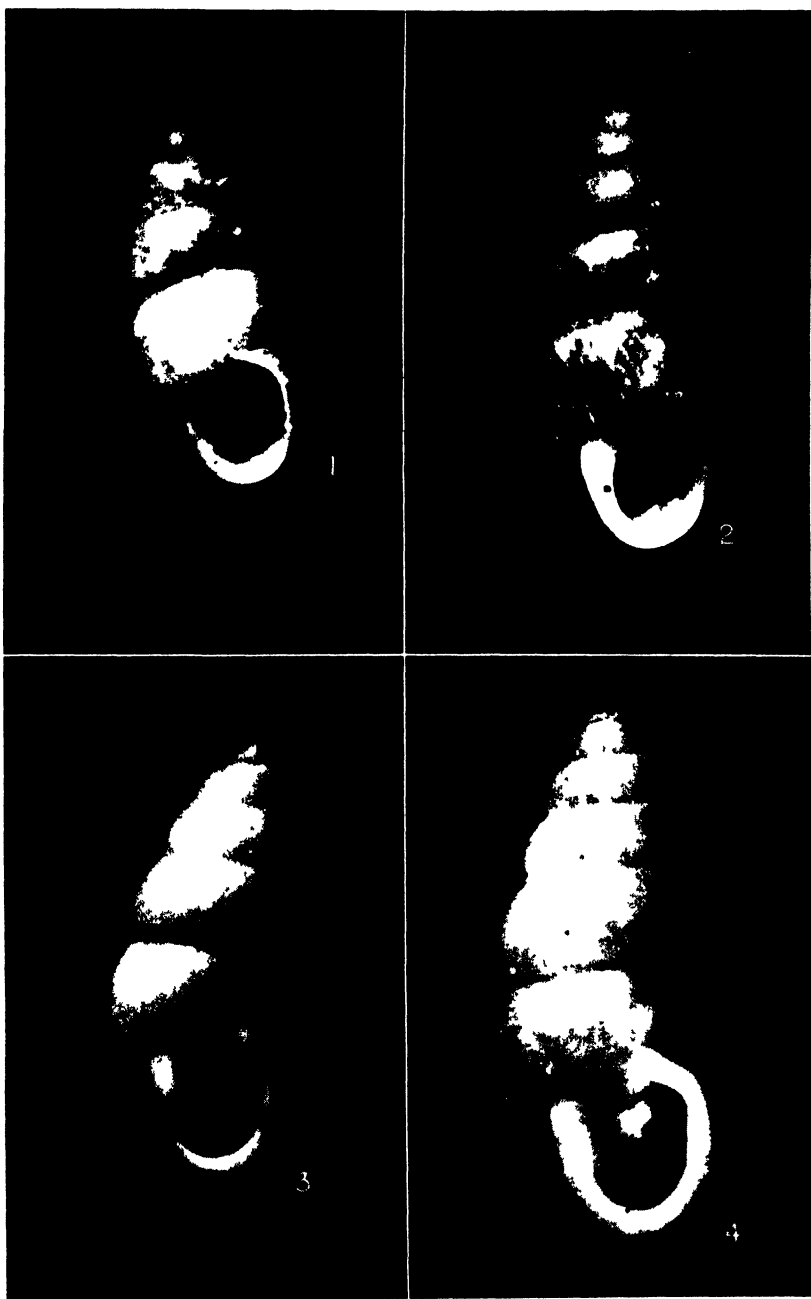


PLATE XXII

EXPLANATION OF FIGURES

FIG. 1—*Pupilla blandi* Morse.

Catalogue number 75, p. 137.

FIG. 2—*Pupilla muscorum* (Linnaeus).

Catalogue number 2373, p. 131.

FIG. 3—*Columella alticola* (Ingersoll).

Catalogue number 3549, p. 147.

FIG. 4—*Pupilla muscorum sinistia* Franzen.

Catalogue number 3827, p. 135, Paratype.

FIG. 5—*Columella hasta* (Hanna).

Catalogue number 214302, United States National Museum, p. 150

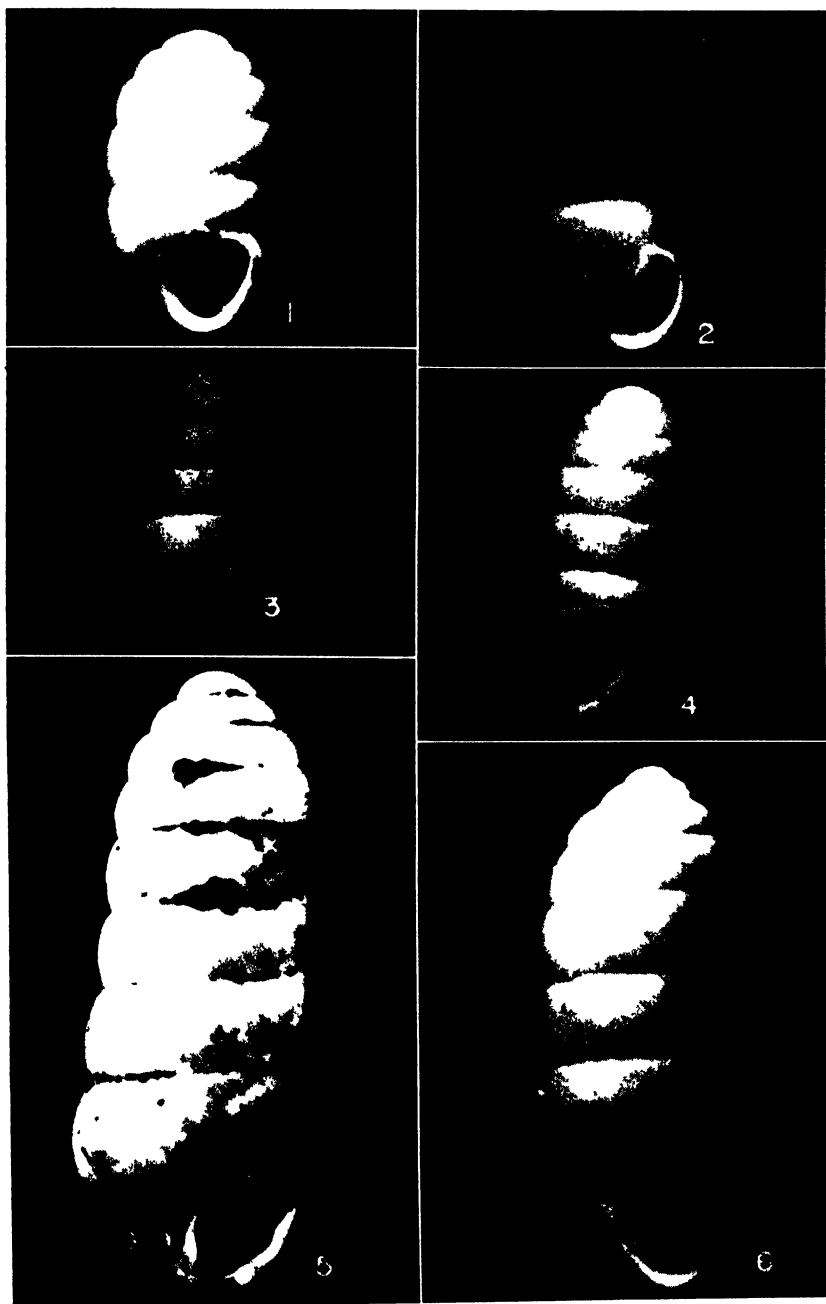
FIG. 6—*Columella tridentata* Leonard

Catalogue number 3734, Holotype, p. 144.

All figures $\times 18$

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PLATE XXII



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A Revision of the Tribe Scaphytopini (*Homoptera*, *Cicadellidae*) in America North of Mexico

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ABSTRACT: The following genera and subgenera of *Cicadellidae* in America north of México are revised: *Platymetopius*, *Japananus*, *Scaphytopius*, *Cloanthanthus*, *Tumeus* and *Vertanus*. Keys to genera, subgenera, species and subspecies are included, as well as prints of male genitalia and last ventral segment of the females. Discusses 73 species and subspecies. Synonyms considered are as follows: (*Cloanthanthus* Ball = (*Deltopinus* Ball = *Convelinus* Ball = *Nasutoideus* Ball = *Platymoideus* Ball); *Japananus hyalinus* (Osborn) = (*Platymetopius cinctus* Matsumura); *Scaphytopius* (*Scaphytopius*) *elegans* (Van Duzee) = (*Scaphytopius elegans* var. *glennanus* Ball = *Scaphytopius floridanus* Ball = *Scaphytopius floridanus* var. *glennanus* Ball); *Scaphytopius* (*Cloanthanthus*) *fuscifrons* (Van Duzee) = (*Platymetopius abruptus* Ball); *Scaphytopius* (*Cloanthanthus*) *dorsalis* (Ball) = (*Platymetopius bicolor* DeLong); *Scaphytopius* (*Cloanthanthus*) *magdalensis* (Provancher) = (*Platymetopius obscurus* Osborn = *Platymetopius carolinus* Lathrop = *Cloanthanthus atratus* DeLong = *Cloanthanthus vaccinium* DeLong); *Scaphytopius* (*Cloanthanthus*) *scriptus* (Ball) = (*Cloanthanthus varius* DeLong); *Scaphytopius* (*Cloanthanthus*) *cinereus* (Osborn and Ball) = (*Platymetopius parvus* Lathrop = *Platymoideus ovidus* Ball); *Scaphytopius* (*Cloanthanthus*) *acutus* (Say) = (*Jasius modestus* Stal = *Platymetopius acutus* var. *dubius* Van Duzee = *Cloanthanthus filamentus* DeLong = *Cloanthanthus tenuis* DeLong); *Scaphytopius* (*Cloanthanthus*) *latus* (Baker) = (*Platymetopius cuprescens* Osborn); *Scaphytopius* (*Cloanthanthus*) *argutus* DeLong = (*Scaphytopius hastus* DeLong = *Scaphytopius lanceus* DeLong); *Scaphytopius* (*Cloanthanthus*) *trilineatus* (Ball) = *Platymetopius peratus* (Van Duzee); *Scaphytopius* (*Cloanthanthus*) *abbreviatus* (DeLong) = (*Cloanthanthus parvus* var. *niger* DeLong). *Cloanthanthus* and *Tumeus* are reduced to subgenera of *Scaphytopius*. *Hebenarus huachucos* Delong is placed in the subgenus *Scaphytopius*. Both lectotype and lectoallotype are designated for the following species: *Japananus hyalinus* (Osborn), *Scaphytopius* (*Cloanthanthus*) *nigricollis* (Ball), *Scaphytopius* (*Cloanthanthus*) *fulvus* (Osborn), *Scaphytopius* (*Cloanthanthus*) *fulvus collaris* (Sanders and DeLong), *Scaphytopius* (*Cloanthanthus*) *cinnamomeus* (Osborn), *Scaphytopius* (*Cloanthanthus*) *angustatus* (Osborn), *Scaphytopius* (*Cloanthanthus*) *nigriviridis* (Ball) and *Scaphytopius* (*Cloanthanthus*) *rubellus* (Sanders and DeLong). Lectoallotype only is designated for each of the following species: *Scaphytopius*

(*Cloanthanus*) *fuscifrons* (Van Duzee), *Scaphytopius* (*Cloanthanus*) *frontalis* (Van Duzee) and *Scaphytopius* (*Cloanthanus*) *cinereus* (Osborn and Ball). Lectotype, allotype and paratypes are designated for each of the following species: *Platymetopius palliolatus* (Ball), *Scaphytopius* (*Tumecus*) *majestus* (Ball), *Scaphytopius* (*Cloanthanus*) *torridus* (Ball), *Scaphytopius* (*Cloanthanus*) *compactus* (Ball), *Scaphytopius* (*Cloanthanus*) *dorsalis* (Ball), *Scaphytopius* (*Cloanthanus*) *scriptus* (Ball), *Scaphytopius* (*Cloanthanus*) *nigriviridis dixianus* (Ball), *Scaphytopius* (*Cloanthanus*) *oregonensis* (Baker), *Scaphytopius* (*Cloanthanus*) *latus* (Baker), *Scaphytopius* (*Cloanthanus*) *trilineatus* (Ball) and *Scaphytopius* (*Cloanthanus*) *abbreviatus* (DeLong). Lectotype only is designated for *Scaphytopius* (*Cloanthanus*) *verecundus* (Van Duzee). Allotype and paratypes are designated for *Scaphytopius* (*Scaphytopius*) *elegans* (Van Duzee), *Scaphytopius* (*Scaphytopius*) *catalinus* (Ball) and *Scaphytopius* (*Cloanthanus*) *loricatus* (Van Duzee). *Scaphytopius* (*Cloanthanus*) *torridus* (Ball), *Scaphytopius* (*Cloanthanus*) *cinnamomeus* (Osborn) and *Scaphytopius* (*Cloanthanus*) *dorsalis* (Ball) are considered full species rather than varieties of other species. *Scaphytopius* (*Cloanthanus*) *xanthanus* (Ball), *Scaphytopius* (*Cloanthanus*) *compactus* (Ball) and *Scaphytopius* (*Cloanthanus*) *collaris* (Sanders and DeLong) have been reduced from full species to subspecies. *Scaphytopius* (*Cloanthanus*) *noqualinus* (Ball) and *Scaphytopius* (*Cloanthanus*) *dixianus* (Ball) are considered subspecies rather than varieties.

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INTRODUCTION

THIS paper is a revision of the tribe *Scaphytopini* in America north of México and includes the following genera: *Platymetopius* Burmeister, *Japananus* Ball and *Scaphytopius* Ball. The genus *Scaphytopius* is divided into four subgenera—*Scaphytopius* Ball, *Cloanthanus* Ball, *Tumeus* DeLong and *Vertanus* Hepner.

More than twenty-five thousand specimens have been examined, including types, paratypes or compared with type specimens of all but the following species: *Japananus hyalinus* (Osborn), *Scaphytopius (Cloanthanus) osborni* (Van Duzee), *Scaphytopius (Cloanthanus) magdalenensis* (Provancher), *Scaphytopius (Cloanthanus) modestus* (Stal), *Scaphytopius (Cloanthanus) analis* var. *castranis* (Ball), *Scaphytopius (Cloanthanus) rubellus* (Sanders and DeLong), *Scaphytopius (Cloanthanus) acutus* (Say) and *Scaphytopius (Cloanthanus) abbreviatus* (DeLong).

Platymetopius Burmeister was named in 1838 as a subgenus with *rostratus* (Herrich-Schaeffer) listed first and no genotype designated. *Japananus* Ball in 1931 with *hyalinus* (Osborn) as genotype and *Scaphytopius* Ball in 1931 with *elegans* (Van Duzee) as genotype. Among the subgenera of *Scaphytopius*, *Cloanthanus* Ball was named in 1931 with *angustatus* (Osborn) as genotype, *Tumeus* DeLong in 1943 with *serrellus* DeLong as genotype and *Vertanus* Hepner in 1946 with *ulcus* as genotype.

In 1910, E. P. Van Duzee published a revision of the genus *Platymetopius* in America. He included twenty-eight species, subspecies and varieties found north of México.

In 1931, E. D. Ball described seven new genera—*Japananus*, *Scaphytopius*, *Deltopinus*, *Convelinus*, *Nasutoideus*, *Platymoideus* and *Cloanthanus*, in which he placed the species formerly considered in *Platymetopius*. However, my studies of the internal male genitalia showed definitely that these genera, as limited, did not satisfactorily show the proper relation of, or group the species. For example: *castranus*, placed in *Convelinus*, was more closely related to those species in *Nasutoideus*; *heldoranus*, named in *Nasutoideus*, proved more like *Platymoideus*; *dorsalis* fitted into no genus as limited. *Japananus* and *Scaphytopius* are the two genera retained of those erected by Ball in 1931, with *Cloanthanus* retained as a subgenus. *Scaphytopius (Scaphytopius)* is retained to include *elegans*, *ritanus* and *catalinus* just as Ball did, plus *huachucus*, named later

by DeLong (1944). All the other species have been placed in *Scaphytopius* (*Cloanthanus*) with the exception of *majestus*, placed in *Scaphytopius* (*Tumeus*) DeLong.

Host plants are known for a great many of the species and this information is given for each individual species in the description.

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The author is deeply indebted to Dr. R. H. Beamer of the University of Kansas, under whose supervision the work was done, for assistance in taxonomic problems and collection of most of the material examined; to Dr. Paul W. Oman of the National Museum, Washington, D. C., for the loan of much material and assistance on taxonomic problems; Dr. Herbert Osborn, Dr. Dwight M. DeLong, and Dr. and Mrs. Joseph N. Knull of Ohio State University for the loan of material and types; Mr. D. A. Wilbur, Kansas State College, for the loan of material and to Mr. R. E. Snodgrass for assistance in morphological problems of the male genitalia.

TECHNIQUE OF STUDY

Equipment Used: Dissecting microscope, for dissection and study of specimens; art gum crasers with a hole, one-sixteenth inch in diameter and one-half inch deep; at least two dissecting needles, one with the tip bent at a one-hundred degree angle; metal loop for transferring genitalia; a casserole for heating caustic potash or soda; a small glass container for distilled water; well slide for dissection in glycerine; slides and cover slips for mounting; slide labels; specimen dissection labels; wax pencil for temporary labels on slide; small vials and corks for staining and placing unmounted genitalia on the same pin with the specimen; a bottle of diaphane for permanent slides; a silk or linen cloth for cleaning slides; tweezers for placing the coverslip on the slide; photographic equipment for making negative prints; photographic paper; eight by five inch cards; photographic mounting paper.

Dissection of Male Genitalia: The head of the insect pin is inserted into the hole in the art gum eraser so that the insect is upside down with the dorsal part of the insect against the eraser. By using a dissecting needle, the entire abdomen is separated from the rest of the insect. The abdomen is transferred to the casserole of caustic potash or soda by a moistened metal loop, where it is boiled slowly for two to ten minutes. As the solution evaporates, distilled water and caustic solution are alternately added to retain about the same amount in the casserole.

Upon removal from the caustic solution, the abdomen is rinsed in distilled water and placed in a drop of glycerine on a slide, ready for dissection. The genital capsule is removed by holding the abdomen with the bent needle in the left hand and using the other needle to pull the capsule loose at its point of attachment. The capsule is then placed so that the tip of the plates and pygofer are directed away from the dissector.

In order to see the parts more easily, the pygofer are separated from the rest of the capsule. To do this the bent needle is placed along the anterior margin where the pygofer and plate join, holding this part against the slide while the straight needle is used to tear gently the connection between the two parts. The anal tube is held by the bent needle and torn out, care being taken that the aedeagus is not pulled off with it. In many species of *Scaphytopius*, the aedeagus is more strongly attached to the base of the anal tube and pygofer lining than to the other genital parts. It has been found necessary to tear loose the inner lining of the pygofer with the aedeagus in order that the aedeagus remain with the other genital parts. This is done by holding the pygofer with the bent needle and gently tearing loose this lining, along with the connectives of the base of the aedeagus. This lining is then teased or cut away so as not to interfere with the genital parts. If possible, the other connective between the plate and pygofer is best left intact until the permanent slide is made. If no slide is desired, the opened capsule is put in a small vial with a drop of glycerine and the pin of the dissected specimen stuck through the cork so that the genitalia are on the same pin as the specimen from which it was taken.

Staining: If slides are to be made, it is best to stain the parts. For this purpose a one and one-half percent aqueous mercurochrome solution is used. The genitalia are rinsed in distilled water to remove the glycerine and put in a small jug containing the stain. The jug is then put on the same pin as the dissected specimen as described above, so there will be no danger of confusion where several genitalia are being stained at the same time. The genitalia are left in the stain from one to twenty-four hours, depending on the darkness of the specimen and intensity of stain desired.

Temporary Slides: Whenever possible, permanent slides should be made, but in some cases it is necessary to make temporary slides so that the genitalia may be placed on the same pin as the dissected insect after the genitalia have been studied or photographed.

In this case the genitalia are rinsed in water to remove all surplus stain and then mounted in glycerine. In most cases negative prints are made of the parts and the prints studied. The cover slip should not be left on the slide any longer than necessary, as this tends to flatten the parts.

Permanent Slides: The genitalia are rinsed in distilled water to remove surplus stain and then placed in a drop of glycerine on a slide (a well slide is best) and any surplus tissue is removed and the plates are separated so that the aedeagus may be seen between them. The genitalia are then put in clean water so that the glycerine is completely removed. A slide and cover slip are then cleaned so that no dirt or lint is present, especially if prints are to be made. A silk or linen cloth is best for this purpose.

The genital parts are then placed in 95% alcohol for thirty seconds to one minute for dehydration. If left longer than this, the paraphyses, especially if coiled, tend to break near the base when the cover slip is put on, and the genitalia are flattened. A drop of diaphane is placed in the middle of the slide and the genital parts put in it with the metal loop. The dissecting needles are then used to separate the pygofer from the rest of the capsule and the parts are arranged as desired. The cover slip is then placed slowly on the diaphane so that no bubbles will be formed. This is best done with tweezers, one side of the cover slip being placed on the slide and the other side slowly lowered until the cover slip touches the diaphane. The cover slip is pressed down slowly and evenly until the parts are flattened. Not over forty-five seconds should be allowed from the time the diaphane is put on the slide until the cover slip is placed in position. The slide should remain in a horizontal position for several days—until the diaphane has completely dried.

The slide is numbered and the insect given a corresponding number. If the last ventral segment of the female is mounted, the same procedure is used and mounted on the same slide with a male of the same species.

Photographing and Studying Genitalia: In studying the male genitalia, negative prints are made and studied. This consists of directing a strong light through the slide, an objective and an ocular, onto sensitive paper, using a magnification of ninety times for the male genitalia and sixty times for the last ventral segment of the female. The prints, four by five inches for the males, half this size for the females, are then mounted, by using photographic mounting

paper, on five by eight inch cards. These cards are given the same number as the slide and filed for study. In determining variation in a species, or differences in the genitalia of different species, these cards are of inestimable value. Any additional information regarding a specimen or species is written on the back side of the card. When specimens are determined, the species name is written on each card.

Prints similar to those used for study were made for this publication, but a dark amber filter was used to allow for a longer exposure, resulting in a clearer image.

CHARACTERS USED IN CLASSIFICATION

The characters used most in separating species were differences in the male genitalia—the paraphyses, aedeagus, and to a lesser degree, the valve, plates and pygofer.

External structural features used were the length and shape of crown; length of pronotum at middle and behind eye in relation to width; length and shape of clypeus, shape of face in lateral view and arrangement of veins in forewing. The variation in color and color pattern was helpful, if accompanied by some structural difference.

TERMINOLOGY

The terminology used by P. W. Oman (1936) was followed in this paper. The *crown* is that part often termed "vertex" and is the dorsal part of the head between the eyes; the *median suture* is the line down the center of the crown, terminating anteriorly in the "*wedge*." By *length of crown* is meant the length on median line and *width between eyes* is the shortest width between the eyes. *Width of pronotum* refers to the distance from one lateral margin to the other; *length behind eyes* refers to the distance from the most posterior portion of the eye to the margin of the pronotum directly posterior to it. The *clypeus* is that part sometimes termed the "frons," length refers to the greatest length and *width at ocelli* refers to the shortest distance between the margins of the clypeus at ocelli. The "*sharks-mouth*" is the inverted V-shaped marking found near the base of clypeus in almost all species of *Scaphytopius*. The *clypellus* is the sclerite extending from the apex of clypeus to the external mouthparts. *Lorae* are the small, circular sclerites on each side of clypellus. The *genae* refers to all the rest of the face. The *forewing* refers to the outer wing, often called the tegmina. The *brachial cell* is that cell in the corium bordering the claval vein.

In regard to the genitalia, Mr. R. E. Snodgrass was consulted as to the names of the various parts. The copulatory organ is termed *aedeagus*; processes of the aedeagus, the genital paraphyses; the parameres, the *styles*; the ventral plate of the male, the *valve*; the ventral apical processes, the *plates*; and the apical dorsal processes, the *pygofers*.

SYNOPSIS OF TRIBE SCAPHYTOPINI

Crown relatively flat with anterior margin distinct; pronotum convex anteriorly and concave posteriorly; forewing with distinct appendix and either one or two cross-veins; clypeus broadest along posterior margin, sinuate or straight at antennae; clypellus usually broadest near apex; genae expanded and extending behind eyes, visible from above; ocelli on margin of crown, near eyes.

KEY TO GENERA OF TRIBE SCAPHYTOPINI

1. Crown with shortest width between eyes greater than length at middle; lateral margin of genae with small concavity beneath eye.....*Platymetopius* Burmeister, page 420
Crown as long as or longer at middle than shortest width between eyes..... 2
2. (1) Only one cross-vein in costal cell; claval veins united at middle,
Japananus Ball, page 423
More than one cross-vein in costal cell or claval veins not united at middle,
Scaphytopius Ball, page 426

SYNOPSIS OF GENUS PLATYMETOPIUS BURMEISTER

Jassus subgenus *Platymetopius* Burmeister, Genera insectorum iconibus illustravit et descripsit. 1: pl. 14, subgenus 4, 1838.

The original reference to the genus *Platymetopius* is as follows:

"Subgenus 4, *Platymetopius*

"37. *J. rostratus* Herr. Schaeff. Fn 122. 2.

"38. *J. vittatus* Fabr. Germ. C. undata Pz. Fn. Germ. C. flammigera de Vill. Ent. (tab. rostra fig. 4 caput cum pronoto et scutello, fig. 5 caput infra.)

Spec. complures, huic subgeneri adscriptae, in Mus. Germari Halae asservantur, quarum nomina haec:

J. impluviatus Germ., e Pennsylvania

J. meta Germ., e Pennsylvania

J. costalis Germ., Brasilia."

The generic name attained nomenclatorial status in the above indicated publication by virtue of the inclusion of the previously described species. The first designation of a type species appears to have been by Van Duzee (Ent. Soc. Amer. Ann. 3: 214, 1910), who designated *Jassus rostratus* Herrich-Schaffer, 1834, as type.

Additional data relative to American species are as follows: Crown much wider than length at middle, anterior margin rounded

to a bluntly pointed apex; pronotum almost parallel margined on median half; forewing with numerous veins to costa; clypeus almost as broad between ocelli as median length and over three times as wide at base as at apex, sinuate at antennal sockets; clypellus more than one-third as long as clypeus, only slightly broadest at apex and barely reaching genae; lateral margin with small concavity beneath eye; relatively deep pit from antennal socket to ventral margin of eye; face convex in lateral view.

KEY TO SPECIES OF PLATYMETOPIUS BURMEISTER

1. Forewing fulvous to brown with milky spots.....1. *vitellinus* (Fitch), page 421
- Forewing green with thin brown area along mesal margin...2. *palliolatus* (Ball), page 422

1. *Platymetopius vitellinus* (Fitch)

Acoccephalus vitellinus, Fitch, Asa, Catalogue with references and descriptions of the insects collected and arranged for the State Cabinet on Natural History—Ann. Report State Cabinet Nat. Hist. of N. Y., IV: p. 57, 1851.

Resembling *palliolatus* but with shorter, yellow crown and brownish forewings. Length: female 6 mm., male 5 mm.

Color: Crown and face ivory to yellow and without darker markings. Pronotum brown, yellowish along anterior margin, indications of three pale vittae, one on median line and another on each side. Scutellum about same color as crown, with a large orange to brown spot near each basal corner. Forewing pale hyaline amber with darker clouded areas in clavus and an irregular, oblique, clouded vitta from apex of clavus to costal margin; veins light.

Structural Characteristics: Crown about half as long at middle as width between eyes, only slightly longer at middle than next eyes; shallow transverse furrow near rounded anterior margin. Pronotum almost twice length of crown, slightly more than twice as wide as length at middle. Clypeus only slightly longer than width at ocelli, distinctly sinuate at antennae. Clypellus relatively broad and only slightly enlarged near apex. Lateral margins of genae concave near eye, convex on apical two-thirds. Face in lateral view distinctly convex, except for slight arcuate concavity joining antennal sockets. Forewing with four or five recurved veins to costa.

Genitalia: Valve triangular, about one and one-half times as wide as length at middle, posterior margin slightly convex on each side of a rounded apex. Aedeagus in ventral view broadest at base, narrowest on apical third; two pairs of lateral processes, one pair from near base extending beyond apex of shaft, and another pair at apex about two-fifths length of shaft. Styles less than one and

one-half times as long as basal width, apical half slender and almost parallel margined. Pygofer roughly triangular, with hook somewhat falcate and sharply pointed.

Last ventral segment of female about twice as wide as length at middle, lateral margins convex, posterior margin with a large, rounded lobe on each side of a small median lobe which may or may not be notched at middle.

Types: Holotype ♂, No. 762, allotype ♀, No. 763, in the New York State Museum, Albany, N. Y.

Material Examined: (British Columbia) Hope, Merritt, Vernon. (Manitoba) Russell, Birch River, Keld, Mafeking, Hartney. (Ontario) Toronto. (Montana) Missoula, Bozeman. (Utah) Barclay. (Colorado) Pagosa Springs, North Peak, Dutch Gap, Ft. Collins. (North Dakota) Tarkio, Hamar. (Minnesota) Two Harbors. (Wisconsin) Rib Mt. State Park. (Michigan) Cheboygan Co., Douglas Lake, Clare Co. (New Hampshire) Bretton Woods, Center Harbor, Notchland. (Tennessee) Clarksville.

Host Plants: Ball (1932) writes "The writer has reported this species as curling and reddening the leaves of roses. Later at Woods Hole it was found curling and coloring the leaves of blackberry and dewberry." Lowry (1933) gives grasses, sedges and shrubs in collection data regarding this species.

Comparative Notes: This species has a wide range but shows little variation except that the specimens from Tennessee were slightly larger.

2. *Platymetopius palliolatus* (Ball)

Eutettix palliolatus, Ball, E. D., Can. Ent., XXXIV: p. 18, 1902.

Resembling *vitellinus* but green with brown pronotum, scutellum and area along clavus. Length: female 5.5 mm., male 5 mm.

Color: Crown green and without markings. Pronotum dark reddish-brown, a pair of irregular broad orange vittae on disc and extreme lateral margin white. Scutellum about same color as pronotum, indication of two oblique light vittae near disc. Face greenish-yellow without definite markings. Forewing hyaline green except for white-margined, narrow brown area from near base of wing, along scutellar and sutural margin to apex of wing; two or three white aeroles in clavus and a like number in apical cells.

Structural Characteristics: Crown about two-thirds as long as width between eyes, slightly more pointed than in *vitellinus*, with

transverse furrow indistinct or absent. Pronotum slightly longer than crown, about twice as wide as length at middle. Clypeus only slightly longer than width at ocelli, sinuate at antennae. Clypellus relatively stout and somewhat enlarged near apex. Face distinctly convex in lateral view. Forewing with three or four recurved veins to costa, especially near apex.

Genitalia: Valve almost twice as wide as length at middle, posterior margin almost straight on each side of a bluntly pointed apex. Plates long and slender. Aedeagus in lateral view short, broadest at base, almost parallel-margined on apical two-thirds with a pair of short, slender apical processes. Styles short, less than twice as long as basal width, slightly sinuate on basal third, with short, rounded apical process.

Last ventral segment of female somewhat converging on lateral margins; posterior margin almost straight except for median lobe notched at middle.

Types: Lectotype ♀, "Tex. Collection C. V. Riley" collected by Belfrage, in the National Museum, Washington, D. C., allotype ♂ and 45 ♂ parallotypes, Seymore, Texas, June 30, 1936, R. H. Beamer, in the Snow Entomological Collections, here designated. Additional ♂ parallotypes from Texas as follows: 1, Palo Pinto Co., July 14, 1928, R. H. Beamer; 1, San Saba Camp, July 1, 1936, R. H. Beamer; 1, Loyal Valley, July 2, 1936, R. H. Beamer; 2, Castroville, July 5, 1936, R. H. Beamer; 1, San Antonio, July 4, 1936, R. H. Beamer; 1, Seguin, June 26, 1938, R. H. Beamer; 3, Concan, July 6, 1936, R. H. Beamer.

Host Plants: Fletcher (1930) writes regarding this species, "on wild sunflower at Dallas."

Comparative Notes: This species is easily recognized by its distinctive color markings and is evidently restricted to Texas.

SYNOPSIS OF GENUS *JAPANANUS* BALL

Japananus, Ball, E D, Can. Ent., LXIII: p. 218, 1981.

The original description of *Japananus* is as follows:

"Resembling *Platymetopius* (sens. strict.) in the narrow head the single cross nervure and the lack of vermiculations but also lacking the supernumerary costal veinlets of that genus.

"A narrow headed form with a long acute vertex in the female, a short and but slightly acute one in the male, a broad pronotum strongly constricted and advanced between the eyes, a large scutellum, broad elytra with simple venation and no reticulations,

a single cross nervure between the sectors. Three large cells occupy the apical portion of the elytra, the first apical forming a long narrow cell against the costa bounded by two short veinlets at right angles to costa. The posterior veinlet is in line with the apex of the outer anteapical, the second apical therefore triangular as in the fifth. Face in profile acutely angled with vertex, front narrow, in the female, produced in a triangle with the vertex. A hairlike dark line just beneath the margin.

"Type of the genus, *Platymetopius hyalinus* Osb.

"This introduced species has no close relationships with any other North American form and while lacking the second sector it does not belong in *Platymetopius* proper nor even close to that group as indicated by the widely different head characters and genital patterns.

"The remainder of the American groups agree in possessing the narrow head with the pronotum narrowed between the eyes, the second cross nervure, a large number of reflexed veinlets to costa, the white triangle or "Sharksmouth" marking on the front and more or less of reticulations and vermiculations. None of these groups are represented in the European fauna as far as known."

Additional data regarding *Japananus* is as follows: Crown flat, sharply pointed, longer than shortest width between eyes, median suture and wedge distinct; pronotum very convex on anterior margin, much wider at middle than behind eyes; forewing with claval veins joined near middle, only two veins to costa and one cross-vein in discal cell; clypeus long and slender, lateral margins hardly sinuate at antennae; clypellus over one-third length of clypeus, enlarged near apex, reaching slightly beyond genae. Shallow concavity on genae from antennae to ventral part of eye.

3. *Japananus hyalinus* (Osborn)

Platymetopius hyalinus, Osborn, Ent. News, XI, p. 501, 1900.

Platymetopius cinctus, Matsumura, Jour. Tohoku Imperial Univ. College of Agri., V: p. 215, 1914.

Yellow to greenish, sharply pointed crown, resembling no other species in the group. Length: female 5.5 mm., male 4.5 mm.

Color: Crown pale green to greenish-brown along margin, becoming darker on disc; apical wedge light. Pronotum mottled dark gray in male, dark green in female, darkest on disc. Scutellum slightly lighter than pronotum with dark markings, if present, irregular in shape. Face pale fulvous fading to gray on lateral margin of genae in male, greenish-yellow in female; irregular dark line just

below base, connecting ocelli. Forewings pale greenish hyaline (almost colorless in male), with following dark markings: four or five lines or dots near middle and a mark in apex of clavus; cross vein on anterior margin of discal cell; area where apical and ante-apical cells join; and a dot on costa opposite apex of clavus.

Structural Characteristics: Crown about one and one-third times as long as width between eyes in male, twice as long as width between eyes in female, almost straight on each side of a sharply pointed apex; concavity on disc; distinct wedge. Pronotum about as long as crown in male; two-thirds length of crown in female, two and one-third times as wide as length at middle and five times length behind eyes, extending beyond eye on each side, posterior margin with shallow notch at middle. Clypeus about twice as long as width at ocelli, not sinuate at antennae. Clypellus large, enlarged near apex. Face in lateral view slightly convex in male, concave between anterior margin of eyes in female. Forewing with the two claval veins united except at ends and only one cross vein to costa.

Genitalia: Genital parts long and slender. Valve triangular, about twice as wide as length at middle. Shaft of aedeagus short, base long and with a pair of slender processes, each bifid on outer fifth, one part straight the other acutely recurved at base and recurved again on apical two-thirds. Plates with a parallel-margined apical process longer than remainder of plate. Styles long, broadest near basal third, slightly lobed on outer margin before blunt outward-projecting apical process.

Last ventral segment of female slightly longer than greatest width, latero-posterior margin convex on basal third, broadly concave on each side of a long median lobe on apical two-thirds.

Types: Lectotype ♂, lectoallotype ♀, Washington, D. C., 1897, J. S. Hine, here designated, in the Osborn Collection, Ohio State University, Columbus, Ohio.

Material Studied: (Connecticut) New Haven. (New Jersey) South Orange, Springfield. (D. C.) Washington. (Virginia) Falls Church, Dismal Swamp, Arlington. (Tennessee) Clarksville. (Ohio) Barberton. (Oregon) Portland.

Host Plants: Ball (1932) writes "—feeds both as nymphs and adults, on the Japanese maple." DeLong (1923) writes "apparently an imported species occurring on Japanese and sugar maples, and perhaps other species of the same group."

Comparative Notes: Evidently this easily recognized, introduced species is fairly well distributed in many parts of the United States.

SYNOPSIS OF GENUS SCAPHYTOPIUS BALL

Scaphytopius, Ball, E. D., Can. Ent., LXIII: p. 218, 1921.

The original description of *Scaphytopius* is as follows:

"Resembling *Platymetopius* as formerly recognized but lacking most of the vermiculations. Allied to *Scaphoideus* Van Duzee, relatively short and stout species with two cross nervures, numerous oblique veinlets to costa and about three or four lines on face paralleling the vertex margins.

"Vertex rather broad and flat, slightly acutely angled and nearly the same length in both sexes—eyes large oblique and enclosing one-half of the pronotum. Face convex, the profile straight and acutely angled with vertex. Front narrow and almost parallel margined below antennae. The 'shark's mouth' markings and the vertex margin both narrowly edged with black, often a line between these. Pronotum much broader than head, the anterior half constricted by the oblique eyes. Elytra as in *Scaphoideus* except for two cross nervures, the venation regular and strongly emphasized on posterior half.

"Type of the genus, *Platymetopius elegans* Van Duzee."

Additional characteristics of the genus are as follows: Crown pointed, longer at middle than shortest width between eyes; pronotum much longer at middle than behind eyes, shortest on lateral margins; forewing with several veins to costa and either one or two veins in discal cell; clypeus narrow, usually slightly sinuate at antennae, broadest at ocelli; clypellus broadest near apex, extending to or beyond margin of genae.

KEY TO SUBGENERA OF SCAPHYTOPIUS BALL

1. Broad, irregular, whitish, sunken band near apex of crown; sharp carina on basal half of clypeus..... *Vertanus* Hepner, page 427
No band nor carina as described above..... 2
2. (1) Crown fulvous without distinct dark markings, with light markings on disc consisting of a long light vitta on each side of median suture posterior to light wedge; distinctly convex on each side of an acutely angled apex. Clypeus uniform brown to black with distinct white line along posterior margin between ocelli and thin sharksmouth reaching to or almost to margin of clypeus,
Tumens DeLong, page 428
Crown and clypeus not as above..... 3
3. (2) Clypellus with apical fourth reaching beyond normal curve of genae,
Scaphytopius Ball, page 432
Clypellus with less than apical fourth reaching beyond normal curve of genae,
Cloanthus Ball, page 439

SYNOPSIS OF SUBGENUS VERTANUS HEPNER

Vertanus, Hepner, L. W., J. Kans. Ent. Soc., p. 87, 1946.

Crown broadly convex on each side of a sharp apex, irregular, sunken, unmarked band before eyes; forewings broad with wide costal cell and several strongly recurved veins to costa; clypeus long, much wider on basal third with a thin median carina on basal half, strongly sinuate at antennae; clypellus slender, slightly enlarged near apex and extending beyond normal curve of genae; lorae oval; lateral margins of genae convex, small pit at base of antennae.

Type of subgenus—*Scaphytopius* (*Vertanus*) *ulcus* Hepner.

4. *Scaphytopius* (*Vertanus*) *ulcus* Hepner

Scaphytopius (*Vertanus*) *ulcus*, Hepner, Jour. Kans. Ent. Soc., XIX, p. 87, 1946.

A striking species unlike any other north of México, with broad colorless band on crown and sharply carinate clypeus. Length: female 5.2 mm., male 5 mm.

Color: Crown with apical fifth mottled brown to fuscous, excepting wedge; broad irregular, colorless band across crown on apical third, remainder with vittae as follows: ivory along outer margin, broad brown, fuscous-margined vitta just inside this, with narrow ivory, fuscous and white lines in that order before thin fuscous line on each side of median suture; slightly lighter in female. Pronotum with broad light and dark alternating vittae, the light ones lined with fuscous. Scutellum about same color as pronotum. Clypeus mottled brown and yellow on apical half, basal half brown on lateral margins, remainder black except white sharksmouth and irregular oblique broad white vittae from near sharksmouth to basal margin. Remainder of face mottled brown and yellow except for white vitta behind eye and dot near ocellus and antenna. Forewing semihyaline yellow, at least on disc of clavus, in apical cells, and along some of veins; remainder semihyaline white or colorless, excepting black clouded areas in clavus and especially in discal and anteapical cells, one conspicuous mark through outer anteapical to costal margin; distinct hyaline spot in posterior end on middle and outer anteapicals.

Structural Characteristics: Crown slightly over twice as long as width between eyes, anterior margin strongly convex on each side of a sharply pointed apex; concave on disc. Pronotum slightly over half as long as crown, two and one-fourth times as wide as length at middle, and three and one-half times length behind eyes, broadly

concave on posterior margin. Clypeus about two and one-fourth times as long as width at antennae, sharp median carina on apical half and rather strong concavity on each side, lateral margins sinuate at antennae. Clypellus relatively stout, enlarged at apex. Face in lateral view strongly concave. Forewing with several vein-like marks in brachial cell, sometimes extra veins on clavus and six or seven strongly reflexed veins to costa.

Genitalia: Valve triangular, about two-thirds as long as greatest width, posterior margin slightly concave on each side of a sharply pointed apex. Aedeagus large, basal portion roughly cone shaped with a large "U"-shaped apical portion about as long as base but about twice as wide. Plates short and truncate. Styles projecting mesally, about twice as long as basal width, large lobe on outer margin just before short, blunt, outward-projecting apical process.

Last ventral segment of female convex and converging on lateral margins; posterior margin with a distinct, blunt lobe on each side of a small median notch.

Types: Holotype ♂, allotype ♀ and 2 pairs of paratypes, Hidalgo, Texas, Dec. 28, 1945, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: 5 ♀ ♀, 2 ♂ ♂, Brownsville, Texas, June 29, 1938, 1 pair, July 3, 1938, R. H. Beamer; 1 ♀, Brownsville, Texas, May 25, 1939, D. J. and J. N. Knull; 1 pair, Progresso, Texas, July 1, 1938, R. H. Beamer; 1 ♂, Taxco, Mexico, Aug. 22, 1936, W. E. Stone; 1 ♂, Mexico, April 10, 1939.

Host Plants: The specimen labelled "Mexico" was collected from cantaloupe.

Comparative Notes: The white band on crown and carina on clypeus easily separates this species from any other. There is evidently much variation in the length of the crown as one of the specimens from Mexico had a longer crown and the other a shorter one than the type, but the internal genitalia proved to be the same.

SYNOPSIS OF SUBGENUS TUMEUS DELONG

Tumeus, DeLong, D. M., Bull. Brook. Ent. Soc., p. 168, 1948.

The original description of the subgenus is as follows:

"Related to *Cloanthanus* but with a flat, more broadened and bluntly angled vertex with the sides convexly rounded to form a narrow, rounded tip. The face is broader than in *Cloanthanus*, but the angled line just beneath the apex of vertex resembles the markings of that genus. The venation is similar in type to *Cloanthanus*, the

coastal veinlets are of the same type and the first anteapical cell is usually decidedly shorter than the second anteapical cell. Genotype *Tumeus serrellus* n. sp."

Additional characteristics regarding the subgenus are as follows: Crown broad, anterior margin convex on each side of a sharply pointed apex, markings consisting of a light vitta on each side of median suture from base to wedge; light vitta on pronotum very faint or absent; forewings relatively long and slender, outer anteapical short, central anteapical narrowed near apex; clypeus dark, without dots, a light line along basal margin joining ocelli and a long slender sharksmouth; slightly sinuate at antennae; clypellus slightly enlarged near apex, barely reaching to normal curve of genae.

KEY TO SPECIES OF SCAPHYTOPIUS (TUMEUS) DeLONG

1. Frons mostly black: California.....5. *majestus* (Ball), page 429
- Frons brown: Texas.....6. *tezanus* DeLong, page 481

5. *Scaphytopius* (*Tumeus*) *majestus* (Ball)

Platymetopius majestus, Ball, E. D., Ent. News, XX: p. 164, 1909.

Resembling *Scaphytopius elegans* somewhat but without the broad dorsal yellow stripe, with crown much broader and with anterior margin distinctly convex on each side of pointed apex. Length: female 5 mm., male 4.5 mm.

Color: Crown yellow and orange with a broad, light vitta on each side of median suture on basal four-fifths, light wedge on apical fifth. Pronotum usually darker than crown, lightest along anterior margin. Scutellum about same color as crown. Clypeus with narrow light band along base between eyes and a long, light sharksmouth; remainder dark chocolate brown, except for lighter brown area between sharksmouth and basal margin. Genae lighter than clypeus. Clypellus and lorae either color of clypeus or genae, or varying between the two colors; light vitta behind eye and dots before eye usually present. Forewing semihyaline brown to fuscous, lightest on clavus and costa, darkest on outer anteapical cell and apex of corium and clavus.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin definitely and broadly convex on each side of a pointed apex. Pronotum half as long as crown in female, proportionately longer in male, about two and one-half times as wide as length at middle and three and one-half times length behind eye; posterior margin convex behind outer margin of eye, concave

at middle with a small median notch. Clypeus about twice as long as width at ocelli, lateral margin sinuate at antennae. Clypellus much larger near apex. Face in lateral view definitely concave. Forewing with six or seven recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin rounded, anterior margin with relatively long lobe on median two-fifths. Single paraphysis, "hinged" on basal third, bifid on outer third, each branch of which is bifid, with the outer branch longer than the inner. Aedeagus very short and broad, resembling a ring. Styles slightly more than twice as long as basal width, slightly sinuate near middle, small lobe on outer margin before curved, outward-projecting apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margin straight near base, convergant on apical three-fifths; posterior margin straight except for median lobe with a notch at middle.

Types: Holotype ♂, Pasadena, California, June 17, 1908, in the National Museum, Washington, D. C. Allotype ♀ and 7 ♀ paratypes, Miramar, Calif, July 28, 1938, R. H. Beamer, in the Snow Entomological Collections. Additional ♀ paratypes from California as follows: 6, Irvine Park, Aug. 4, 1939, R. H. Beamer; 1, Boulevard, July 26, 1938, R. H. Beamer; 1, San Antonio Canyon, Aug. 4, 1938, R. H. Beamer; 1, San Antonio Canyon, Aug. 4, 1938, R. I. Sailer; 2, Mt. Tamalpais, Aug. 15, 1938, R. H. Beamer; 5, La Jolla, July 13, 1941, R. H. Beamer; 1, Arroyo Seco River, Aug. 8, 1938, R. H. Beamer; 3, Mint Canyon, July 6, 1933, R. H. Beamer; 2, San Diego, Aug. 7, 1935, 1, Dec. 24, 1941, R. H. Beamer; 1, Nipomo, July 24, 1935, R. H. Beamer.

Host Plants: Ball (1932) writes "—taken in June by the writer on a tall *Rhus* growing in isolated clumps at Pasadena." Specimens collected on *Photinia arbutifolia* at Mt. Tamalpais, California, and on *Rhus integrifolia* at Miramar, California, were examined.

Comparative Notes: This dark, slender species can hardly be confused with any other species in California, and the male genitalia is distinctly different from any other, with the single, twice bifid paraphysis.

Scaphytopius (Tumeus) texanus DeLong

Tumeus texanus, DeLong, D. M., Bull. Brook. Ent. Soc., XXXVIII: p. 170, 1948.

Resembles *majestus* somewhat, but with shorter crown and light brown dorsum. Length: female 5 mm., male 4.5 mm.

Color: Crown pale greenish-fulvous, thin dark line along anterior margin, pale vitta on each side of median suture on basal three-fourths, median vitta on apical fourth; pale areas bordered by dark. Pronotum darker than crown, lightest on anterior and lateral margins, usually some vermiculations on disc; vittae sometimes evident on lateral margins. Scutellum about same color as crown, light in each basal corner and an irregular, slightly oblique line from lateral margin to anterior margin, usually fuscous lined. Face chocolate brown excepting light markings as follows: thin line along anterior margin, long sharksmouth, three or four pairs of short, oblique lines on disc of clypeus, line behind eye and a dot before eye. Forewing semihyaline greenish-fulvous, large milky aeroles in clavus, anteapical and apical cells, most cells in corium, except middle apical cell, with large hyaline area, dark vermiculations throughout; veins light except on apex and costal margin.

Structural Characteristics: Crown one and two-thirds times as long as width between eyes in male, slightly longer in female, anterior margin slightly convex on each side of bluntly pointed apex in male, more strongly convex in female. Pronotum about three-fifths length of crown in male, relatively shorter in female, two and one-half times as wide as length at middle and four times length behind eyes, posterior margin only slightly concave. Clypeus about twice as long as width at ocelli, lateral margins constricted at antennae, shallow concavity along sharksmouth. Clypellus stout and enlarged near apex. Face in lateral view concave between anterior margin of eyes, especially in female. Forewing with numerous vein-like marks in brachial cell and about seven recurved veins to costa.

Genitalia: Valve about four-fifths as long as greatest width, posterior margin convex on each side of a bluntly pointed apex; anterior margin with short, broad median lobe. Plates short but sharply pointed. Paraphysis single, bulblike at base with a slender hairlike apical part. Aedeagus attached to base of paraphysis; shaft in lateral view, straight, narrowing to apex with a pair of short, slender apical processes. Styles slightly more than twice as long as basal width, outer margin with pointed lobe before long, slender, curved process on apical half.

Last ventral segment of female almost twice as wide as length at middle, lateral margins straight, posterior margin convergent to a median lobe with a small notch at middle.

Types: Holotype ♂, allotype ♀, Brownsville, Texas, May 8, 1935, J. N. Knull, in the DeLong Collection, Ohio State University, Columbus, Ohio.

Material Studied: (Texas) Concan, Progresso, Brownsville.

Host Plants: The host plant is not known.

Comparative Notes: This species is easily recognized in southern Texas by the clouded dark face and distinctive crown.

SYNOPSIS OF SUBGENUS SCAPHYTOPIUS BALL

Scaphytopius, Ball, E. D., Can. Ent., LXIII: p. 218, 1931.

For original description of subgenus, see description of genus *Scaphytopius*.

Additional characteristics of the subgenus are as follows: Crown straight to slightly convex on each side of apex, markings light, but sometimes lined with dark; pronotum with vittae absent or indistinct on disc; forewing with several recurved veins to costa; clypeus sinuate at antennae, light sharksmouth near posterior margin between eyes typically present; clypellus relatively long with apical fourth extending beyond normal curve of genae; loral margins oval; genae with shallow pits for antennae.

KEY TO SPECIES OF SCAPHYTOPIUS (SCAPHYTOPIUS) BALL

1. Color hyaline brown except for wide yellowish area covering crown, middle half of pronotum, all of scutellum and mesal margin of clavus,
 7. *elegans* (Van Duzee), page 432
- Markings different than above 2
2. (1) Face unicolor; last ventral segment of female not split on posterior margin; male parapsysis roughly "T"-shaped.....8. *ritanus* Ball, page 434
- Frons usually darker than rest of face; last ventral segment of female split on posterior margin; male parapsysis not "T"-shaped..... 3
3. (2) Parapsysis of male and last ventral segment of female split to near base,
 9. *catalinus* (Ball), page 436
- Parapsysis of male and last ventral segment of female split only partly to base,
 10. *huachucus* (DeLong), page 437

7. *Scaphytopius* (*Scaphytopius*) *elegans* (Van Duzee)

Platymetopius elegans, Van Duzee, E. P., Ent. Amer., VI: p. 94, 1890.

Scaphytopius floridanus, Ball, E. D., Can. Ent., LXIII: p. 220, 1931.

Scaphytopius elegans var. *glennanus*, Ball, E. D., Can. Ent., LXIII: p. 220, 1931.

Scaphytopius floridanus var. *roseus*, Ball, E. D., Can. Ent., LXIII: p. 221, 1931.

Resembling *ritanus* but more slender, with longer crown, and forewings unclouded on corium except for apical cells. Length: female 5 mm., male 4.7 mm.

Color: Crown white to yellow with brown markings as follows: broad "Y"-shaped mark before each eye and a thin line on each side of median suture on apical two thirds. Pronotum yellow on disc, brown on each side, excepting one or two light vittae near lateral margin. Scutellum yellow. Face yellow, excepting fuscous-bordered broad sharksmouth, a line along basal margin between ocelli, and in darkly marked specimens a vitta behind eye and shorter one near ocellus. Forewing hyaline except for opaque yellow area in clavus and smaller, lighter area in apical cells; veins concolorous in clavus, dark brown to fuscous in corium.

Structural Characteristics: Crown one and one-half times as long as width between eyes in male, slightly longer in female, anterior margin straight to slightly convex on each side of a sharp apex; wedge about two-fifths length of crown. Pronotum almost as long as crown, slightly more than twice as wide as length at middle, and four times length behind eye; posterior margin slightly concave. Clypeus slightly more than twice as long as width at ocelli, somewhat sinuate at antennae. Clypellus long and slender and about one and one-half times as wide near apex as narrowest point. Face in lateral view straight to slightly concave between anterior margin of eyes. Forewing with about eight recurved veins to costa and claval veins sometimes joined near middle.

Genitalia: Valve about two-thirds as long as greatest width, posterior margin bell-shaped, anterior margin with broad, short median lobe. Paraphysis "T"-shaped, broadest near base, apical, laterally-projecting processes sharp at apex, and with tiny teeth along the edges. Aedeagus small, about as wide as greatest width, notched at middle of flattened apical margin. Plates short and bluntly pointed. Styles about three times as long as basal width, sinuate on basal third, large lobe on outer margin on median third and bluntly pointed process on apical third.

Last ventral segment of female about twice as wide as length at middle, lateral margins straight and converging, posterior margin slightly convex.

Types: Holotype ♀, "California, Coquillet," in the Iowa State College collection, Ames, Iowa. Allotype ♂ and one paratype ♂, Idyllwild, California, Aug. 3, 1935, R. H. Beamer, here designated, in Snow Entomological Collections. Additional ♂ paratypes from California as follows: 1, San Margareta, Aug. 6, 1912, E. D. Ball; 1, Dulzura, Aug. 9, 1935, R. H. Beamer; 1, Lompoc, Aug.

7, 1938, R. I. Sailer; 2, Santa Rosa, Aug. 16, 1938, R. H. Beamer; 1, Campo, Aug. 10, 1935, R. H. Beamer; 1, Pine Valley, July 27, 1938, R. H. Beamer; 11, La Jolla, July 13, 1941, R. H. Beamer; 2, Escondido, July 15, 1941, R. H. Beamer.

Additional Material Studied: (Arizona) Arivaca, Oak Creek Canyon, Chiricahua Mts., Yarnell, Jerome and Ruby. (Utah) Pintura and Zion National Park. (New Mexico) Silver City. (Texas) Sutton Co. (Florida) Sanford, La Belle, Old Town, Ocala and Yankeetown.

In addition to the types listed above, the following paratypes were on hand for study: 1 ♀ *floridanus*, Sanford, Florida, July 22, 1926, E. D. Ball, and a pair of *glennanus*, Yarnell Hts., Aug. 20, 1929, and Oct. 8, 1929, E. D. Ball.

Host Plants: Ball (1932) writes "*Scaphytopius elegans* Van Duzee is a Pacific coast form which the writer has found feeding exclusively on the live oaks of that region. Var. *glennanus* Ball was found by the writer throughout southern Arizona feeding, both nymphs and adults, on the different live oaks, especially *Q. turbinella* and *oblongifolia*."

"*S. floridanus* Ball with its var. *roseus* Ball are strictly confined to the under side of the live oak (*Q. virginiana*) in the Florida region. The margins of the leaves are revolute and furnish a fine hiding place for the young nymphs."

Comparative Notes: *S. elegans* was named from California, darker specimens from Arizona were named the variety *glennanus* and lighter specimens from Florida named *floridanus*. There are intermediate forms both in color and distribution, specimens having been studied from New Mexico, Texas and Mexico. Specimens collected in Florida in the winter are often as dark as the typical California specimens. The variety *roseus* is a reddish form, evidently specimens in which the yellow color is replaced by red, a rather common occurrence in other species of the group.

The broad, yellow vitta on dorsum readily separates this species from any other in the genus.

8. *Scaphytopius* (*Scaphytopius*) *ritanus* Ball

Scaphytopius ritanus, Ball, E. D., Can. Ent., LXIII: p. 221, 1921.

Resembling *elegans* but broader, with shorter crown, and with more clouded area on corium. Length: female 5 mm., male 5 mm.

Color: Crown yellow to orange, a thin, wavy brown line along

anterior margin; wedge, long vitta on each side of median suture and small irregular area inside each eye, lighter. Pronotum about same color as crown, often gray on disc and broad, irregular vitta formed by absence of pigment. Scutellum about same color as crown, usually somewhat darker just inside each basal angle. Clypeus reddish-fulvous, thin black line along base between ocelli; sharksmouth and three or four pairs of short, oblique lines beneath, light. Remainder of face about same color as clypeus, sometimes darkest on lateral margins, white spot near each ocellus and antenna and sometimes vitta behind eye. Forewing hyaline to semi-hyaline brown, light band before apex of clavus extending across anterior ends of anteapical cells to costa and another light band just before apex. These light bands may be white or devoid of color. Veins light brown anteriorly, becoming dark on costa and at apex.

Structural Characteristics: Crown one and one-third times as long as width between eyes, straight on each side of a pointed apex; wedge about one-third length of crown. Pronotum about as long as crown, two and one-fourth times as wide as length at middle and about four and one-half times length behind eyes, posterior margin almost straight. Clypeus about twice as long as width at ocelli, lateral margins slightly sinuate at antennae. Clypellus long and enlarged near apex. Face convex in lateral view. Forewing with five or six recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin rounded, anterior margin with rather narrow, median lobe. Plates short and sharply pointed. Paraphysis "T"-shaped, broadest at base, with apical, laterally projecting processes margined with tiny teeth. Aedeagus slender, about half as long as style, and with a pair of short apical processes. Style about three times as long as basal width, sinuate near middle, a large lobe on outer margin just before slender, pointed, outwardly curved, apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margin almost straight and convergant, posterior margin with a wide, short median lobe.

Types: Holotype ♀, Tucson, Ariz., June 19, 1929, allotype ♂, Santa Rita Mts., May 12, 1929, E. D. Ball, in the National Museum, Washington, D. C.

Material Studied: (Arizona) Ruby, Santa Rita Mts., Huachucua Mts., Benson, Santa Catalina Mts. and Patagonia.

Host Plants: Ball (1932) writes "—taken as nymphs and adults from the live oaks of southern Arizona, especially *Q. oblongifolia* and *emoryi*."

Comparative notes: The female of this species is easily separated from *catalinus* and *huachucus* by the last ventral segment being unnotched, the male has the distinctive "T"-shaped parapsis. This species was placed in *Hebenarus* DeLong but the great similarity of the genitalia of *ritanus* and *elegans* shows these two species very closely related and undoubtedly in the same genus.

9. *Scaphytopius* (*Scaphytopius*) *catalinus* (Ball)

Scaphoideus catalinus, Ball, E. D., Can. Ent., XLI: p. 82, 1909.

Resembling *ritanus* but smaller, clypeus somewhat darker than adjoining area of face and more distinct band on forewing. Length: female 5 mm., male 4 mm.

Color: Crown light fulvous with wedge and broad vitta on each side of median suture usually faintly indicated; faint black line along anterior margin. Pronotum slightly darker than crown, lightest along anterior margin; vittae usually indicated on margin. Scutellum orange with white spot at apex and another on each side near middle. Clypeus slightly darker than remainder of face, white line along basal margin between eyes; sharksmouth and two or three pairs of oblique lines beneath, light. Lorae, gena next clypeus below antennae and apical half of clypellus, ivory to light fulvous. Lateral margins of genae about same color as clypeus; light vittae behind eye and much shorter ones near ocellus and antennae usually at least indicated. Forewing hyaline or semihyaline brown on basal half, across middle of anteapical cells and apex, white to colorless in a band across base and apex of anteapicals, giving a two-banded appearance.

Structural Characteristics: Crown about as long as width between eyes, anterior margin straight to slightly convex on each side of bluntly pointed apex; wedge about one-fourth length of crown. Pronotum about as long as crown, two and one-half times as wide as length at middle and five times length behind eye; posterior margin concave with a small median notch. Clypeus slightly over one and one-half times as long as width at ocelli, lateral margin definitely sinuate at antennae. Clypeus long and enlarged near apex. Face in lateral view convex. Forewing with a few vein-like markings in brachial cell and eight or nine recurved veins to costa.

Genitalia: Valve almost one and one-half times as wide as length at middle, rounded on posterior margin, anterior margin with broad median lobe. Plates short but sharply pointed. Paraphysis bifid almost to base, each fork curved, long, and sharply pointed. Aedeagus almost as long as basal width, a sharp median process at apex, and a pair of lateral, apical processes, truncate and slightly produced anteriorly. Styles about three times as long as basal width, sinuate on basal third, large lobe on outer margin before a blunt, outward-projecting process on apical third.

Last ventral segment of female about twice as wide as greatest length, median notch on posterior margin reaching almost to base, forming two oval lobes.

Types: Holotype ♀, "Santa Rita Mts., Ariz. 5 to 8000 ft. June, F. H. Snow" in the National Museum, Washington, D. C. Allotype ♂ and four ♂ paratypes, Santa Rita Mts., Arizona, July 17, 1932, R. H. Beamer, here designated, in the Snow Entomological Collections. One other ♂ paratype—Santa Rita Mts., July 6, 1933, E. D. Ball.

Host Plants: Ball (1932) writes "—taken as nymphs and adults from the live oaks of southern Arizona, especially *Q. oblongifolia* and *emoryi*."

Comparative Notes: The deeply emarginate last ventral segment of the female is the best external criterion for separating this species from any other. This species has been listed in *Hebenarus* but the similarity of the genitalia of this species to *elegans* and *ritanus* would cause it to be retained in this genus.

10. *Scaphytopius* (*Scaphytopius*) *huachucus* (DeLong)

Hebenarus huachucus, DeLong, Pan-Pac. Ent., XXII: p. 41, 1944.

Resembling *catalinus* but larger, with darker clypeus and paraphysis bent near middle. Length: female 5.5 mm., male 5 mm.

Color: Crown yellow to orange with light markings, if present, as follows: thin line along anterior margin, wedge, long vitta on each side of median suture and an irregular area inside each eye. In many specimens collected in the summer, these markings are absent, while in fall or winter collected specimens, the markings are fuscous-lined and distinct. Pronotum usually slightly darker than crown, lightest along anterior margin; vittae usually absent, but sometimes indicated along lateral margins. Scutellum yellow to dark orange with white dot at apex and another on each lateral

margin. Clypeus much darker than remainder of face, orange, excepting fuscous bordered white line along basal margin between eyes, and white sharkmouth; sometimes oblique lines on disc faintly indicated. Remainder of face yellow to fulvous with vitta behind eye and spot near ocellus and antennae usually evident. In fall and winter specimens, the orange is replaced by dark brown and the remainder by light brown. Forewing hyaline brown on basal half, across middle of antepical cells and in middle apical cell, remainder semihyaline white or colorless, giving a faintly two-banded appearance across apex of and base of antepical cells.

Structural Characteristics: Crown only slightly longer than width between eyes, slightly convex on each side of a bluntly pointed apex; wedge about one-third length of crown. Pronotum almost as long as crown, about two and one-half times as wide as the length at middle and four and one-half times length behind eyes; posterior margin convex and with a small, broad median notch. Clypeus about one and two-thirds times as long as width at ocelli, lateral margin only slightly, if any, sinuate at antennae. Clypellus long and enlarged at apex. Forewings with numerous veins in brachial cell and numerous recurved veins on costa and usually extra veins on clavus.

Genitalia: Valve about as long as greatest width, posterior margin rounded; anterior margin with long median lobe. Paraphysis long, curved and almost parallel margined on basal two-thirds, split on apical two-thirds, with two pairs of short apical processes, one pair straight and the other recurved; another pair of short, straight processes on ventral margin on apical third where the paraphysis curves. Aedeagus small, ring-like, almost separated dorsally. Style less than three times as long as basal width, sinuate near middle, conspicuous lobe on outer margin before short, bluntly pointed, finger-like, apical process.

Last ventral segment of female straight on lateral margins; posterior margin with a deep median notch reaching almost to middle, forming two distinct lobes.

Types: Holotype ♂, allotype ♀, Huachucua Mts., Ariz., July 20, 1936, and June 9, 1935, J. N. Knull, in the DeLong collection, Ohio State University, Columbus, Ohio.

Material examined: (Arizona) Huachucua Mts., Chiricahua Mts., and Santa Rita Mts.

Host Plants: Unknown, but probably live oaks.

Comparative Notes: This species is placed in *Scaphytopius* because of its similarity to other members of this genus, most nearly related to *catalinus*, but larger and with darker frons.

SYNOPSIS OF SUBGENUS CLOANTHANUS BALL

Cloanthanus, Ball, E. D., Can Ent., LXIII, p. 219, 1931

The original description of this subgenus is as follows:

"Resembling *Platymetopius* (sens. strict.) but with a narrower vertex, a shark's mouth marking on frons, and two cross nervures. Closely related to *Platymoideus* but without the vermiculations on the anterior portion of elytra.

"Vertex flat, acutely angular, longer than wide, narrowing from the front of the eye to the base where it is very narrow. Face long, convex, acutely angled with vertex as seen from side. Front long and narrow especially below the antennae. Pronotum much broader than head. Venation regular, two cross nervures between sectors and numerous short reflexed veinlets to costa. The claval nervures are united by a cross nervure and usually tied to the suture by another one. The vertex, pronotum and anterior portion of elytra are usually unicolorous in sharp contrast to the dark venation on the posterior portion of elytra

"Type of the genus *Platymetopius angustatus* Osb."

Additional characters of the subgenus are as follows: crown flat or depressed, usually pointed; forewing with anteapical cells almost the same length; numerous recurved veins to costa, darkest on outer anteapical and adjacent area of costa; lateral margins of clypeus straight to sinuate at antennae, sharksmouth usually present; clypellus parallel-margined or enlarged near apex, extending to, or slightly beyond, normal curve of genae; antennae in shallow pits near ventral margin of eyes.

Typical Color Pattern if Present: Crown with light markings as follows: Wedge; line along anterior margin; two pairs of spots on posterior margin, one pair near median suture and one spot next each eye; either three pairs of spots in a band across crown before eyes, or long straight or arcuate mark on each side of median suture (the band before eyes is usually present in short-crowned species, the long or arcuate markings usually in long-crowned species). Pronotum with seven vittae, one on median line and three on each side, usually more pronounced nearest lateral margins. Scutellum with light mark at apex, in each basal corner and on lateral margin half-way between apex and base; dark area inside each basal corner

and line across middle. Forewing variable, darkest on apical cells, outer anteapical cell and adjacent area of coastal cell. Clypeus with light, fuscous-margined sharksmouth near base. Genae darkest on lateral margins, fuscous-margined white vitta behind eye, two short vittae before eye, one near ocellus and another near base of antennae.

KEY TO SPECIES OF SCAPHYTOPIUS (CLOANTHANUS) BALL

1. Crown pattern absent, indistinct or consisting of two to three distinct light spots on disc of crown, sometimes coalesced or reduced, or forming a transverse band before the eyes, more or less complete, the median pair of spots often elongate; usually relatively short crown..... 2
 Markings on crown taking the form of lineations, often arcuate, usually one long mark on each side of median suture; usually long crown..... 43
2. (1) Dorsum opaque yellow or fulvous to reddish, crown often darkest; scutellum without large dark area; crown parallel-margined or at most slightly angled; aedeagus long and with short, anteriorly projecting apical processes 3
 Color and shape of crown not as above, or if so, aedeagus much different... 4
3. (3) Color yellow 11. *nigricollis* (Ball), p. 443
 Color fulvous to reddish 12. *torridus* (Ball), p. 445
4. (2) Dorsum opaque white with fuscous markings; crown with irrorate dark areas at apex and broken band between anterior half of eyes, 13. *desertanus* (Ball), p. 446
 Dorsum and crown not as above..... 5
5. (4) Four mm. or less in length; light markings on crown usually thin, the median pair often extending to base; last ventral segment of female much lighter than rest of venter; aedeagus with two short, erect apical processes on dorsal margin..... 14. *irroratus* (Van Duzee), p. 447
 More than four mm. in length; or if not, light markings on crown larger and shorter or aedeagus variable, but not as above..... 6
6. (5) Light fulvous, face with darker markings, especially in male: Arizona, 15. *irroratus* subsp. *xanthanus* (Ball), p. 449
 Not light fulvous; or if so, face without darker markings or not from Arizona 7
7. (6) Crown fulvous and short; face irrorate with brown throughout; Arizona, 16. *irroratus* subsp. *nogalinus* (Ball), p. 450
 Crown not as above; or if so, face not irrorate with brown throughout..... 8
8. (7) Entire face white or yellow in sharp contrast to much darker venter; no genital paraphysis in male 9
 Face not as above; or if so, with genital paraphysis, although often small, 12
9. (8) Processes at apex of aedeagus at least half as long as shaft, 17. *albifrons* Hepner, p. 452
 Processes at apex of aedeagus less than half as long as shaft..... 10
10. (9) Light markings on crown slender; general color fuscous to black; aedeagus with short, erect apical processes at apex; Texas to California, 18. *loricatus* (Van Duzee), p. 453
 Light markings on crown broader; general color lighter; aedeagus not as above; Texas 11
11. (10) Aedeagus with wing-like apical processes..... 19. *pennatus* Hepner, p. 455
 Aedeagus with more slender, laterally-projecting apical processes, 20. *flavifrons* Hepner, p. 457
12. (8) Light band on crown before eyes complete except for two or three fine dark lines; many tiny fine dots and vermiculations more or less evenly distributed throughout forewing; aedeagus long and abruptly curved on apical third 21. *anisacanthus* (Ball), p. 458
 Crown and forewing not as above; or if so, aedeagus much different..... 13

13. (12) Forewings translucent greenish-fulvous, crown mostly light except for irregular brown band between anterior margin of eyes; southern Texas,
22. *contractus* Hepner, p. 459
Forewings and crown not as above; or if so, not from southern Texas..... 14
14. (13) Dorsum brown with ivory markings; face infuscated on lateral margins; aedeagus broad and enlarged at apex, small paraphyses,
23. *brunneus* Hepner, p. 460
Dorsum and face not as above, or if so, with different genitalia..... 15
15. (14) Male plates truncate at apex; female last ventral segment broadly concave with a slender median notch; face dark..... 16
External genitalia not as above, or if so, face not dark..... 18
16. (15) Crown evenly irrorate with light, no band before eyes,
24. *fuscifrons* (Van Duzee), p. 461
Crown with a band before the eyes..... 17
17. (16) Area of crown next pronotum with some dark markings, especially next eye, four and one-half mm. or more in length,
25. *fuscifrons* subsp. *compactus* (Ball), p. 463
Area of crown next pronotum without dark markings, less than four and one-half mm. in length..... 26. *fuscifrons* subsp. *minutus* Hepner, p. 464
18. (15) Face bright yellow throughout, dorsum light fulvous... 27. *dodonanus* (Ball), p. 466
Face not bright yellow throughout; or if so, dorsum not light fulvous..... 19
19. (18) Crown with light band before eyes and at base, giving a more or less distinct four-banded appearance—two ivory and two fuscous; forewings not distinctly darkened at apex..... 28. *celtidus* (Ball), p. 467
Crown not as above; or if so, forewings darkened at apex..... 20
20. (19) Forewings semihyaline white with many dark dots throughout; scutellum with large area next each basal corner; erect genital paraphyses extending slightly beyond simple aedeagus..... 29. *californiensis* Hepner, p. 468
Forewings and scutellum not as above; or if so, genitalia different..... 21
21. (20) Light band before eyes broad, distinct and almost complete; remainder of crown black except for apical wedge and irrorations next pronotum..... 22
Crown not as above..... 23
22. (21) Scutellum primarily black..... 30. *diabolus* (Van Duzee), p. 470
Scutellum with few, if any, black markings..... 31. *pallidiscutus* Hepner, p. 472
23. (21) Clavus of forewing semihyaline fulvous without darker markings; genital paraphyses of male bifid on outer third..... 24
Clavus not as above, or if so, paraphyses different..... 25
24. (22) Pronotum fulvous..... 32. *fulvus* (Osborn), p. 473
Pronotum fuscous..... 33. *fulvus* subsp. *collaris* (Sand. and DeLong), p. 476
25. (23) Clypeus bright yellow and without markings on apical two-thirds; outer margin of lorae infuscated; forewings blackish,
34. *frontalis* (Van Duzee), p. 476
Face and forewings not as above..... 26
26. (25) Crown heavily irrorate, but without definite pattern..... 27
Crown not heavily irrorate; or if so, with pattern..... 28
27. (26) Scutellum fulvous and with few or no fuscous or black markings,
35. *cinnamomeus* (Osborn), p. 477
Scutellum dark, with fuscous or black markings throughout,
36. *deliensis* Hepner, p. 479
28. (26) Crown and face ivory and without markings..... 37. *dorsalis* (Ball), p. 480
Crown or face with darker markings..... 29
29. (28) Entirely dark fuscous to blackish, except for small light marks on crown,
38. *nigriifrons* (DeLong), p. 481
Not entirely fuscous to blackish..... 30
30. (29) Forewings fulvous with large milky spots throughout,
39. *amplinetus* Hepner, p. 482
Forewings not as above..... 31
31. (30) Crown only slightly longer at middle than next eye and only slightly longer than width between eyes..... 40. *osborni* (Van Duzee), p. 483
Crown distinctly longer at middle than next eye..... 32

32. (31) Crown fulvous and without dark markings and with a distinct spot on each side of median suture on disc; entire dorsum about same color; Florida, 41. *andromus* (Ball), p. 485
Crown and dorsum not as above, or if so, not from Florida..... 33
33. (32) Crown more than twice as long as width between eyes, 42. *verecundus* (Van Dusee), p. 486
Crown shorter than above..... 34
34. (33) Dorsum reddish-brown, markings on crown small, but distinct, 43. *insolitus* Hepner, p. 487
Dorsum and crown not as above..... 35
35. (34) Aedeagus notched along dorsal margin; eastern..... 36
Aedeagus tube-like; western (except *angustatus*)..... 38
36. (35) Genital paraphysis with small pointed, lateral lobe near middle, 44. *magdalenus* (Provancher), p. 488
Genital paraphysis without lobe; or if present, nearer apex..... 37
37. (36) Light band before eyes only about half complete; not Florida, 45. *scriptus* (Ball), p. 490
Light band before eyes on crown almost complete; Florida, *scriptus* subsp. *meridianus* Hepner, p. 492
38. (36) Color greenish-yellow; eastern..... 47. *angustatus* (Osborn), p. 493
Color not greenish-yellow; western..... 39
39. (38) Scutellum primarily ivory to orange, with black markings; remainder of dorsum black..... 48. *calliandrus* (Ball), p. 494
Scutellum not marked as above; dorsum lighter..... 40
40. (39) Dorsum white with dark dots; face with only scattered dark dots, 49. *analis* var. *castranis* (Ball), p. 496
Dorsum and face not as above..... 41
41. (40) Crown dark brown with marks before the eyes thin and directed toward apex; aedeagus relatively long..... 50. *radiatus* Hepner, p. 497
Crown and aedeagus not as above..... 42
42. (41) Aedeagus very short; styles more than twice as long as greatest width; crown almost same color throughout .. 51. *modicus* Hepner, p. 498
Aedeagus longer; styles less than twice as long as greatest width, 52. *palidiscapitatus* Hepner, p. 499
43. (1) Forewing with only green or brown clouded area on anterior half; usually four or less dark reflexed veins to costa..... 44
Forewings with vermiculations or dots on anterior half; usually more than four reflexed veins to costa..... 45
44. (43) Color greenish..... 53. *nigriviridis* (Ball), p. 500
Color brownish..... 54. *nigriviridis* subsp. *dixianus* (Ball), p. 502
45. (43) Crown white, with a large black mark around and behind wedge, forewings opaque white with sparse fuscous vermiculations.. 55. *heldoranus* (Ball), p. 503
Crown and forewings not as above..... 46
46. (45) General color pale gray; crown short; Southwest, 49. *analis* var. *castranus* (Ball), p. 496
Color and crown not as above, or if so, not Southwest..... 47
47. (46) Fuscous-margined, light vitta on clypeus from near sharkmouth to near apex..... 56. *vittifrons* Hepner, p. 504
Without such a line on clypeus..... 48
48. (47) Color pale fulvous, except for dark area over most of pronotum and basal half of scutellum..... 33. *fulvus* subsp. *collaris* (Sanders & DeLong), p. 475
Color various, but not as above..... 49
49. (48) Arcuate markings very indistinct or absent..... 50
Arcuate or long discal markings more distinct..... 51
50. (49) Forewings greenish-fulvous with dark veins restricted to apical half, 47. *angustatus* (Osborn), p. 498
Forewings brownish..... 35. *cinnamomeus* (Osborn), p. 477
51. (49) Crown light fulvous with few or no fuscous markings; crown of female at least two and one-half times as long as width between eyes; that of male almost as long..... 57. *slossonae* (Van Dusee), p. 506
Crown not as above..... 53

52. (51) Color dark reddish brown; face dark and in lateral view distinctly concave 58. *rubellus* (Sanders and DeLong), p. 507
 Color not as above 58
53. (52) Pronotum yellowish, forewing semihyaline light with veins and markings consisting primarily of dots; crown with many vermiculations, 59. *cinereus* (Osborn and Ball), p. 508
 Pronotum, forewing and crown not as above 54
54. (53) Face unmarked yellow, at least on disc of clypeus 55
 Face dark, even on disc of clypeus 64
55. (54) Dorsum white with veins and markings consisting primarily of dots; crown with many vermiculations 60. *guterranus* (Ball), p. 510
 Dorsum and crown not as above 56
56. (55) Pygofer of male broadly concave on basal half of outer margin; face yellow on disc 61. *acutus* (Say), p. 511
 Pygofer of male not as above, or if so, face not yellow on disc 57
57. (56) Entire dorsum fulvous; crown less than one and one-half times width between eyes 62. *oregonensis* (Baker), p. 513
 Dorsum and crown not as above 58
58. (57) Crown long, darkest on disc with arcuate markings pale or indistinct, 63. *latus* (Baker), p. 515
 Crown not as above 59
59. (58) Aedeagus in ventral view much smaller at apex than at base; eastern, 64. *argutus* DeLong, p. 516
 Aedeagus not as above, or if so, not eastern 60
60. (59) Crown primarily dark brown to fuscous 65. *fuscicephalus* Hepner, p. 517
 Crown lighter colored 61
61. (60) Crown greenish or light fulvous; southern 66. *viridicephalus* Hepner, p. 519
 Crown not as above, or if so, not southern 62
62. (61) Aedeagus broad; genital paraphyses enlarged on apical two-fifths, 67. *utahensis* Hepner, p. 520
 Aedeagus slender; genital paraphyses, if enlarged, only on outer fourth.... 63
63. (62) Less than five and one-half mm. in length 68. *graneticus* (Ball), p. 521
 More than five and one-half mm. in length 69. *canus* Hepner, p. 523
64. (54) Crown at least two and one-half times as long as width in female; twice as long as width in male, very slender; crown mottled, with three to five distinct lines 65
 Crown not as above 66
65. (64) Plates truncate, aedeagus long 70. *trilineatus* (Ball), p. 524
 Plates pointed, aedeagus short 72. *trilineatus* subsp. *spicatus* Hepner, p. 525
66. (64) Less than four mm. in length; face lighter on disc of clypeus than on genae 73. *abbreviatus* (DeLong), p. 527
 More than four mm. in length; face about same color throughout, 73. *triangularis* DeLong, p. 529

11. *Scaphytopius* (*Cloanthanus*) *nigricollis* (Ball)

Platymetopius nigricollis, Ball, E. D., Ent. News, XXVII, p. 205, 1916.

Resembles *torridus* but yellow with a dark crown and mottled face. Length: female 4 mm., male 3.5 mm.

Color: Crown yellow and brown mottled, area next pronotum, apical wedge and a spot on each side, light. Sometimes the dark is somewhat reduced. Pronotum and scutellum bright yellow with sometimes a few scattered dark spots. Face yellow and brown mottled, sharksmouth small, vitta behind eye distinct. Forewings semihyaline white to yellow, usually with small dark dots throughout; veins yellow, usually darker at apex and along costal margin.

Structural Characteristics: Crown only slightly longer than width between eyes, almost parallel-margined in male, more produced in female. Pronotum about as long as crown, two and one-half times as wide as length at middle and five times as wide as length behind eyes. Clypeus about twice as long as width at ocelli, only slightly broader at base than at antennae. Face distinctly convex in lateral view. Forewing with venation typical; about nine recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin somewhat convex on each side of a rounded apex; anterior margin with a broad, rather flat, median lobe. Plates slender. Aedeagus "J"-shaped, with dorsal portion quite broad and about two-thirds as long as shaft, which is slender and with a pair of short, anterior-dorsally projecting, sharply pointed processes; base short. Styles about four times as long as basal width, sinuate at middle, only slightly lobed on outer margin before short, curved, finger-like apical process.

Last ventral segment of female about one and two-thirds as wide as length at middle, lateral margins straight and slightly converging, posterior margin straight to slightly concave on each side of prominent median lobe, notched at middle.

Types: Lectotypes ♀, Mojave, California, July 30, 1912, lectoallotype ♂, St. George, Utah, E. D. Ball, here designated, in the National Museum, Washington, D. C.

Material Studied: (Utah) St. George. (Arizona) Vail, Tucson, Congress Junction, Alamo, Yarnell, Black Mts., Santa Rita Mts., Chiricahua Mts., Empire Mts. and Mt. Graham. (New Mexico) Alamogordo, Rodeo and Socorro Co. (Texas) Presidio Co., Ft. Stockton and 65 miles south of Marathon.

Host Plants: Ball (1932) writes "—found as nymphs and adults on the creosote bush (*Larrea tridentata*) in southern Utah and Arizona."

Comparative Notes: In some specimens the dark dots are absent, only the crown being colored. This species might possibly be confused with a male *nigriviridis*, but is much broader, with a shorter crown and more dark on the crown.

Nigricollis was made genotype for the genus *Convelinus*, but there is no good structural difference to separate it from other *Cloanthanus*. In fact, *castranus*, mentioned by Dr. Ball as belonging to *Convelinus*, has genital structures like typical *Cloanthanus*, with

paraphyses. Although *nigricollis* and *torridus* have similar genital structures and feed on the same host plant, no evidence of hybridization has been noted.

12. *Scaphytopius (Cloanthanus) torridus* (Ball)

Platymetopius brevis var. *torridus*, Ball, E. D., Ent. News, XXVII, p. 205, 1916.

Resembles *nigricollis* but dark fulvous to reddish-brown with different pattern on crown. Length: female 3.5 mm., male 3.2 mm.

Color: Crown usually tan and white mottled; spot on posterior margin next each eye, line on each side median suture broadest at base, irregular band before eye, and small apical wedge, light. Pronotum about same color as crown, sometimes a series of white marks along anterior margin. Scutellum same color as crown, with typical light markings at least indicated. Face mottled brown and fulvous, lightest on lorae; small sharksmouth and light vitta behind eye, distinct. Some specimens are mottled brown and red.

Structural Characteristics: Crown about as long as width between eyes in male, slightly longer in female; wedge very short. Pronotum only slightly shorter than crown, about two and one-half times as broad as length at middle, five times as broad as length behind eyes. Clypeus about twice as long as width at ocelli; only slightly sinuate at antennae. Clypellus stout, only slightly enlarged at apex. Forewing with typical venation, seven or eight indistinct, recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin somewhat convex on each side of a bluntly pointed apex; anterior margin with a broad, short median lobe. Plates slender. Aedeagus "J"-shaped with dorsal portion broad and about two-thirds as long as shaft, which is slender, and a pair of dorso-anteriorly projecting, short, apical processes; base short. Styles about four times as long as greatest width, almost parallel-margined to finger-like apical process.

Last ventral segment of female almost twice as wide as length at middle, lateral margins slightly convex, posterior margin distinctly convex.

Types: Lectotype ♀, Calexico, Calif., June 18, 1909, E. D. Ball, here designated, in the National Museum, Washington, D. C. Allotype ♂, Big Bear Lake, Calif., July 26, 1932, R. H. Beamer, here designated, in the Snow Entomological Collections. Parallotype ♂♂ as follows: (California) 2, Barstow, June 1, 1935, P. W. Oman; 3, Jacumba, Aug. 12, 1935, R. H. Beamer; 1, Jacumba, May

18, 1941, D. J. and J. N. Knull; 1, Ontario, June 12, 1908; 6, Kelso, June 9, 1908, E. D. Ball; 1, Palm Spgs., Sept. 2, Hubbard; 2, Indio, June 4, 1935, P. W. Oman; 1, Holtville, June 1, 1935, P. W. Oman; 1, El Centro, June 1, 1935, P. W. Oman; and 1, San Diego Co., Coquillet. (Nevada) 2, Las Vegas, March 7, 1934, 1, April 28, 1934, E. W. Davis. (Utah) 2, St. George, Sept. 8, 1930, E. W. Davis and 1, "Dixie," Aug. 8, 1915, E. D. Ball. (Arizona) 1, Littlefield, Sept. 10, 1930, 1, June 7, 1931, E. W. Davis; 2, Black Mts., July 13, 1932, R. H. Beamer; 1, Congress Jct., Aug. 27, 1935, E. D. Ball; 2, Cong. Jct., June 14, 1937, D. J. and J. N. Knull; 1, Wickenburg, May 31, 1935, P. W. Oman; 2, Empire Mts., Aug. 18, 1935, E. D. Ball; 1, Gila Bend, June 8, 1931; 1, Yuma, Aug. 25, 1929, 1, Oct. 30, 1931, 2, Nov. 1, 1931, E. D. Ball; 2, Mohawk, Oct. 29, 1931; 1, Ajo Mts., Apr. 20, 1935, 4, July 22, 1937, E. D. Ball; 4, Tucson, May 31, 1929, 1, July 24, 1930, E. D. Ball; 1, Pima Co., July 27, 1927, R. H. Beamer; 1, Cochise, Aug. 24, 1935, R. H. Beamer and 1, Santa Rita Mts., June 8, 1937, D. J. and J. N. Knull.

Host Plants: Ball (1932) writes "—confined to the creosote bush." The author has examined specimens collected from *Larrea tridentata*, *Larrea mexicana* and *Covillea tridentata*, probably different names for the same plant.

Comparative Notes: Unlike *nigricollis*, this species is about the same color throughout. It varies considerably both in size and color. It was originally described as a variety of *brevis*, a Jamaica species, but apparently differs considerably from that species.

13. *Scaphytopius (Cloanthanus) desertanus* (Ball)

Nasutoideus desertanus, Ball, E. D., Can. Ent., LXIII, p. 225, Oct., 1931.

Resembles *heldoranus*, but with irregular black markings between anterior part of eyes, forming a dark, incomplete band; without genital paraphyses. Length: female 3.5 mm., male 3.3 mm.

Color: Crown white except for irregular black markings around wedge, irregular black markings inside anterior margin of each eye and usually two to four lines connecting these two dark areas. Pronotum milky semihyaline, sparsely marked with dark dots, vittae usually faintly indicated. Scutellum white to fulvous with usually a few dark vermiculations on basal half. Face ivory with a few dark dots or vermiculations in area of small sharksmouth and along lateral margin; apex of clypellus dark. Forewing milky translucent with sparsely spaced fuscous dots, especially along veins; apical cells clouded; veins in costa dark.

Structural Characteristics: Crown almost twice as long as width between eyes in female, shorter in male, anterior margin somewhat convex on each side of bluntly pointed apex. Pronotum two-thirds as long as crown in female, three-fourths as long in male; about two and one-half times as wide as length at middle, slightly over four times as wide as length behind eyes. Clypeus about twice as long as width at ocelli in male, slightly longer in female, only slightly sinuate near antennae. Face convex in lateral view. Forewing with venation typical and about nine or ten recurved veins to costa.

Genitalia: Valve about two-thirds as long as greatest width, posterior margin rounded; anterior margin with broad, short, median lobe. Aedeagus "J"-shaped, dorsal part broadest, shaft narrowed and slightly curved to a pair of small, apical processes. Style only slightly over twice as long as basal width, outer margin with distinct lobe before laterally projecting, finger-like apical process.

Last ventral segment of female about twice as wide as length at middle, latero-posterior margin rounded, without median lobe or notch.

Types: Holotype ♀, allotype ♂, Tucson, Arizona, May 5, 1929, E. D. Ball, in the National Museum, Washington, D. C. One pair of paratypes, Tucson, Arizona, Aug. 31, 1929, E. D. Ball, were on hand for study.

Additional Material Studied: (Arizona) Wickenburg, Sentinel, Coolidge Dam, Granite Dell, Glenn Oaks, Apache Jct., Phoenix and Littlefield. One specimen collected by Dr. Ball at Brownsville, Texas, on the same pin with a *castratus* specimen may be mislabelled, as no other specimen has been seen from east of Arizona.

Host Plants: Dr. Ball (1932) writes "—found breeding abundantly on the gray bur sage (*Franseria deltoides*) in Arizona."

Comparative Notes: This small gray species is easily recognized by its small size and color. It can be easily separated from *heldoranus* by the dark irrorate area at apex of crown, whereby *heldoranus* has a solid black area at apex of crown.

14. *Scaphytopius (Cloanthanus) irroratus* (Van Duzee)

Platymetopius irroratus, Van Duzee, E. P., Ann., Ent. Soc. Amer., III, p. 227, 1910.

Resembles *loricatus*, but with dark face and with aedeagus produced on dorsal margin. Length: Female 4 mm., male 3.6 mm.

Color: Crown mottled brown and light with light markings as follows: Wedge, thin line along anterior margin; three pairs of elon-

gate spots forming an incomplete band before eyes, and two pairs of spots on posterior margin, one pair next median suture (often joined to median spots of band before eyes) and one next each eye. Pronotum about same color as crown, light vittae usually at least faintly indicated. Scutellum fulvous to brown with typical light markings. Face of male fulvous with brown to fuscous markings throughout, darkest on lateral margins of genae, lightest in area next lorae and broad line behind eye; sharksmouth small but usually distinct. Face of female usually lighter. Forewing brown to fuscous, veins and irrorations darker at apex and costal area opposite apex of clavus. Often the fulvous coloration is lacking and forewing is merely white with dark markings.

Structural Characteristics: Crown about as long as width between eyes in male, longer in female, margins slightly convex to a dull point in male, margins more convex in female; wedge one-third to one-fourth as long as crown. Pronotum about three-fourths as long as crown, about two and one-half times as broad as length at middle. Clypeus over twice as long as width at ocelli, only slightly sinuate at antennae. Forewing with eleven or twelve recurved veins to costa.

Genitalia: Valve about three-fourths as long as greatest width, posterior margin somewhat convex on each side to a bluntly pointed apex; anterior margin concave on each side of a relatively narrow median lobe. Plates broadest near base, apices relatively short and slender. Aedeagus roughly "U"-shaped with a broad process and smaller shaft, slightly narrowed to apex with a pair of dorsal apical processes; base shorter than shaft. Styles distinctly less than twice as long as greatest width, narrowest near middle, large lobe on outer margin before finger-like apical process.

Last ventral segment of female somewhat over half as long as greatest width, latero-posterior margin rounded.

Types: Lectotype ♂, Tia Juana, México, June 15, 1908; lectoallotype ♀, San Diego, Calif., June 16, 1908, E. D. Ball, here designated, in the National Museum, Washington, D. C. These were on hand for study.

Additional Material Studied: (California) Irvine Hills, Orange Co., San Diego Co., Anaheim, Sunset Beach, Bonsail, La Jolla, Monrovia, Alpine, Laguna Beach, Otay, Lemon Cove, Escondido, Quatay, Lakeside, Los Angeles, Riverside, Pasadena, Santa Barbara, Oxnard, Ontario, Redding and Santa Monica. (Arizona) Tucson, Phoenix, Patagonia, Chiricahua Mts., Granite Dell, Yuma and

Bangs. (New Mexico) Blue Spgs. and Carlsbad. (Texas) San Juan, Presidio, Del Rio, Brownsville, Pecos, Sutton Co., Bee Co., Premont Co., Ft. Stockton, Ozona, Kendall Co., Karnes Co., El Paso Co., Valentine, Hidalgo, Sarita, McAllen, Corpus Christi, Laredo, Jim Wells Co., Concan, Carrizo Spgs., George West, Sheffield, Sanderson, San Ygnacia, Comstock, Bexar Co., Ft. Davis, Catarina, Marfa and Marathon.

Host Plants: A large series were collected at Bonsail, California, by R. H. Beamer on *Ambrosia* sp. Other collection data give *Eysenhardia texana* at Sanderson, Tex., peach foliage at El Paso and Bexar Co., Texas, *Amaranthus* sp. in Bexar Co., Texas, and adults and nymphs on *Heterotheca subaxillaris* in Bexar County. The large series from *Ambrosia* in California and the presence of nymphs on *H. subaxillaris* in Texas would suggest one of these two plants as the normal host.

Comparative Notes: As might be expected from its wide distribution, this species varies considerably both in color and size. Color varies from fulvous to dark gray, with the entire dorsum about the same color; the face varies from total infuscation to markings only along the lateral margins. The small size and usually dark face will separate it from most species found along the southern part of the United States from California to Texas, where it is one of the most common species in the genus.

15. *Scaphytopius (Cloanthanus) irroratus xanthanus* (Ball)

Nasutoides xanthanus, Ball, E D., Can Ent., LXIII, Oct., p 225, 1931.

Resembles *irroratus* but lighter in color, larger and with a blunter crown. Length: female 4.2 mm., male 4 mm.

Color: Crown fulvous with light markings as follows: wedge, narrow line along anterior margin, two pairs of large, rather elongate spots on each side before eye; a long, broad line from near wedge to base on each side of median suture and a small spot on posterior margin next each eye. Pronotum lighter than crown, vittae usually faintly visible. Scutellum ivory to fulvous with typical light markings usually evident, especially in male. Face of male pale fulvous with brown irrorations, especially behind eyes and on basal half of clypeus, lighter in female; sharksmouth and line behind eye usually distinct. Forewing semihyaline pale fulvous with large milky aeroles throughout, usually a few brown dots scattered throughout; veins darkest on posterior and costal margins.

Structural Characteristics: Crown about one and two-thirds times as long as width between eyes, anterior margin convex on each side of a blunt apex, less convex and more pointed in the female; wedge short. Pronotum somewhat shorter than crown; about two and one-half times as wide as length at middle and about four and one-half times as wide as length behind eyes. Clypeus somewhat over twice as long as width at ocelli, only slightly sinuate near antennae. Clypellus relatively slender and broadest near apex. Face in lateral view slightly convex. Forewing with venation typical and nine or ten recurved veins to costa.

Genitalia: Valve about two-thirds as long as greatest width, posterior margin broadly rounded, very broad at middle; anterior margin distinctly concave on each side of a rounded median lobe. Plates relatively narrow. Aedeagus "J"-shaped with dorsal portion slightly largest, shaft slender, almost parallel-margined to apex, which bears a pair of slender dorsal processes and smaller, spine-like dorsal processes; base short. Styles less than twice as long as greatest width, narrowest on basal third, broadly lobed on median third before an apical, finger-like process.

Last ventral segment of female almost twice as wide as length at middle, latero-posterior margin almost evenly rounded.

Types: Holotype ♀, allotype ♂, Tucson, Arizona, May 10, 1929, E. D. Ball, in the National Museum, Washington, D. C.

Material Studied: (Arizona) Sabino Canyon, Ajo, Tucson and Apache Jct.

Host Plants: Ball (1932) writes "—exclusively on the bur sage (*Franseria ambrosioides*) in Arizona."

Comparative Notes: This species resembles *nogalinus* rather closely, but may be separated by its lighter color, slightly larger size and longer crown.

16. *Scaphytopius (Cloanthanus) irroratus nogalinus* (Ball)

Nasutoides irroratus var. *nogalinus*, Ball, E. D., Can. Ent., LXIII, p. 226, Oct., 1931.

Resembles *irroratus* but larger, lighter in color and with a shorter crown. Length: female 4 mm., male 3.8 mm.

Color: Crown fulvous irrorate with light, with white markings as follows: narrow line along anterior margin, wedge, two or three pairs of elongate dots in an area around wedge, two pairs of dots on posterior margin, a small pair next eyes and a longer pair near median suture. Pronotum fulvous with dark dots, milky vittae

usually distinct. Scutellum yellow to fulvous with typical ivory markings. Face ivory to fulvous with brown irrorations, usually lightest in area of clypellus and lorae; sharksmouth and vitta behind eye distinct. Forewing semihyaline pale fulvous with large milky aeroles throughout, veins dark, especially in costal area.

Structural Characteristics: Crown over two-thirds as wide as length at middle, almost parallel-margined in male, longer in female; wedge short. Pronotum almost as long as crown, about two and one-half times as wide as length at middle and four times as wide as length behind eyes. Clypeus slightly over twice as long as width at ocelli, only slightly sinuate at antennae. Clypellus relatively slender and only slightly enlarged at apex. Forewing with several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve slightly less than two-thirds as long as greatest width, posterior margin rounded; anterior margin with long median lobe. Plates broadest near base, narrow on outer half. Aedeagus "U"-shaped, base slender, dorsal part broadest, shaft curved, with a pair of erect apical processes from dorsal margin. Styles slightly less than twice as long as greatest width, sinuate near middle, lobed on outer margin just before outward projecting, finger-like apical process.

Last ventral segment of female about half as long as greatest width, latero-posterior margin rounded.

Types: Holotype ♀, allotype ♂, Santa Rita Mts., Arizona, June 22, 1930, E. D. Ball, in the National Museum, Washington, D. C. A pair of paratypes, Tucson, Arizona, June 9, 1929, E. D. Ball, were on hand for study.

Additional Material Studied: (Arizona) Rincon Mts., Patagonia, Santa Rita Mts., Ajo Mts., Sabino Canyon, Santa Catalina Mts., Baboquivara Mts., Mustang Mts., Ruby, Huachucua Mts., Tubac and Chiricahua Mts.

Host Plants: Ball (1932) writes "—beaten in small numbers from oaks on the lower slopes of the mountains in southern Arizona. The small numbers and lack of nymphs would suggest that the adults may have flown up from some plant growing beneath the trees."

Comparative Notes: This species is easily recognized by its short, light crown and dark face.

17. *Scaphytopius (Cloanthanus) albifrons* Hepner

Scaphytopius (Cloanthanus) albifrons, Hepner, L. W., Jour. of Kan. Ent. Soc., XIX, p. 89, 1946.

Resembling *loricatus* but smaller, lighter in color, and with long processes at apex of aedeagus. Length: female 4.1 mm., male 3.9 mm.

Color: Crown mottled brown with light markings as follows: wedge, narrow line along anterior margin, three pairs of spots before eyes, the outer largest and the inner long and slender; two pairs of spots along posterior margin, a large pair next median suture and another pair behind eyes. Pronotum semihyaline fulvous with fuscous dots throughout except for distinct vittae. Scutellum yellow to dark fulvous with typical markings light. Face ivory to yellow with sometimes a few brown marks in area of sharksmouth and dots along lateral margins of genae, especially behind eyes; apex of clypellus black. Strangely enough, the dark specimens from Florida lack all facial color except black tip of clypellus. Specimens collected in Texas in the winter usually have the facial markings. Forewing semihyaline fulvous with brown veins and large milky aeroles throughout. In most specimens from Florida, the fulvous is replaced by brown to black.

Structural Characteristics: Crown one and two-thirds as long as width between eyes in female, somewhat shorter in male, slightly convex on outer margins, rather sharp pointed at apex, especially in female. Pronotum about three-fifths as long as crown in female, slightly longer in male, almost three times as wide as length at middle and four times length behind eye. Clypeus over twice as long as width at ocelli, lateral margin broadly concave near middle. Clypellus broadest near apex. Face in lateral view slightly concave between anterior margin of eyes. Forewing with outer claval vein approaching second claval vein at crossvein, usually numerous vein-like markings in brachial cell; about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin rounded, anterior margin narrowed to a broadly rounded lobe at middle. Plates wide near base, apical portion relatively short and slender. Aedeagus "J"-shaped, shaft longer than base, broadly curved, almost parallel-margined with a pair of long slender, apical processes almost two-thirds as long as shaft. Styles about twice as long as greatest width, outer margin concave on basal third, small lobe before finger-like process on apical third.

Last ventral segment of female slightly less than twice as wide as length at middle, lateral margins slightly convex, posterior margin evenly produced, but only slightly longer at middle than at sides.

Types: Holotype ♂, allotype ♀, 24 ♀ and 9 ♂ paratypes, Brownsville, Texas, Dec. 27, 1945, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (Texas) 1 ♀, 3 ♂ ♂, Brownsville, Jan. 2, 1932, 1 ♂, Jan. 3, 1932, E. D. Ball; 7 ♀ ♀, 8 ♂ ♂, Brownsville, May 31, 1933, P. W. Oman; 10 ♀ ♀, 1 ♂, Brownsville, Dec. 29, 1945 (in palm forest), R. H. Beamer; 1 ♂, Brownsville, Aug. 8, 1937, D. J. and J. N. Knull; 1 ♂, Hidalgo, July 30, 1938, 19 ♀ ♀, 1 ♂, Dec. 28, 1945, R. H. Beamer; 1 ♀, Hidalgo, July 28, 1928, A. M. James; 2 ♀ ♀ and 1 ♂, Cameron Co., Aug. 3, 1928, R. H. Beamer. (Florida) 2 ♂ ♂, 1 ♀, Wakulla, July 10, 1939, R. H. Beamer; 1 ♂, Fruitland, Aug. 11, 1930, R. H. Beamer; 2 ♂ ♂, Sanford, Nov. 18, 1926, 1 ♂, June 22, 1926, E. D. Ball; 4 ♀ ♀, 1 ♂, Tampa, Oct. 17, 1925, E. D. Ball; 1 ♀, Cocoa, May 5, 1926, E. D. Ball; 2 ♀ ♀, La Belle, July 16, 1939, R. H. Beamer; 1 ♀, La Belle, July 16, 1939, P. B. Lawson; 2 ♀ ♀, La Belle, July 16, 1939, P. W. Oman; 1 ♂, La Belle, April 21, 1921, D. M. DeLong; 1 ♂, Likely, July 24, 1934, R. H. Beamer; 1 ♂, Naples, May 14, 1928, E. D. Ball; 2 ♂ ♂, Miami, April 1, 1921, D. M. DeLong; 1 ♂, Homestead, May 16, 1926, E. D. Ball; 1 ♀, Paradise Key, April 8, 1921, D. M. DeLong and 1 ♂, Key West, July 20, 1939, R. H. Beamer.

Host Plants: No host plant is known.

Comparative Notes: This is apparently the only species in Florida in which the face is entirely light. In Texas, however, this species is easily confused with *loricatus* and *pennatus* but the male genitalia easily separate them. *Albifrons* was described by DeLong (1943) as *loricatus* but that species, described from California, extends only into Texas, and this species, distinctly different, is also found in Florida.

18. *Scaphytopius (Cloanthanus) loricatus* (Van Duzee)

Platymetopus loricatus, Van Duzee, E. P., Bull. of Buffalo Soc. Nat. Hist., V, p. 205, 1894.

Resembling *frontalis*, but more slender, with a sharper crown, face with few or no dark markings and without genital paraphyses in the male. Length: female 4.5 mm., male 4 mm.

Color: Crown brown with light markings as follows: wedge, a thin line along anterior margin, two pairs of slender marks before

eyes and a line on each side of median suture joining or almost joining a pair of spots at base next median suture; a spot on posterior margin next each eye. Pronotum irrorate with brown, slightly darker than crown, with pale vittae distinct. Scutellum yellow to brown with typical light markings. Face yellow to light fulvous, much lighter than adjoining area of venter, sometimes a few indistinct darker markings in area of "sharksmouth" and at apex; line behind eye sometimes faintly indicated; apex of clypellus dark. Forewing brown to fuscous with milky aeroles throughout, especially in costal cell.

Structural Characteristics: Crown in male about one and two-thirds as long as width between eyes, slightly longer in female, almost straight on each side of a rather blunt apex. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and about three and one-half times length behind eyes. Clypeus slightly over twice as long as width at ocelli, narrowing evenly to clypellus on apical three-fourths; clypellus broadest near apex. Face in lateral view almost straight, sometimes slightly concave between anterior margin of eyes of female. Forewing with venation typical, a few marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve over two-thirds as long as greatest width, posterior margin broadly rounded; anterior margin concave on each side of a truncate median process. Aedeagus "J"-shaped, shaft almost as long as plates, parallel margined to abruptly curved portion on apical two-fifths, then narrowed to a pair of erect processes on ventral side and a much shorter process on dorsal side; base short. Styles less than twice as long as greatest width, evenly narrowed from base to middle, distinct lobe on outer margin before outwardly projecting, bluntly pointed, apical process.

Last ventral segment of female about one and one-half times as wide as length at middle, posterior margin broadly convex without lobes or notches.

Types: Lectotype ♂, California, Coquillett, in the Iowa State College collection, Ames, Iowa. Allotype ♀, Brea, California, July 29, 1935, R. H. Beamer, here designated, in the Snow Entomological Collections. Parallotype ♀♀ as follows: (California) 1, Alpine, July 9, 1929, R. H. Beamer; 1, Lompoc, Aug. 7, 1938, R. I. Sailer; 4, Laguna Beach, Orange Co., Aug. 10, 1931, Billie Moore; 2, Pasadena, June 17, 1908, E. D. Ball; 1, Santa Barbara, April 25, 1908, E. D. Ball; 1, Los Angeles, P. R. Uhler; 1, Los Angeles Co., Coquillett

and 1, San Diego Co., July 4, 1929, R. H. Beamer. (Arizona) 1, Patagonia, June 24, 1933, 3, Aug. 22, 1935, 1, Aug. 21, 1935, R. H. Beamer; 7, Patagonia, Sept. 7, 1929, 3, Aug. 8, 1930, 1, Oct. 5, 1935, 4, Sept. 10, 1933, E. D. Ball; 10, Patagonia, Oct. 23, 1937, P. W. Oman; 4, Tucson, June 23, 1929, 1, May 23, 1929, 1, Sept. 20, 1929, 1, June 28, 1930, 1, July 16, 1935, E. D. Ball; 4, Mesa, Sept. 10, 1938, 1, Dec. 16, 1939, Christensen; 11, Santa Cruz River, near Tubac, Oct. 23, 1937, P. W. Oman; 6, Santa Cruz Valley, Sept. 6, 1937, E. D. Ball; 2, Santa Cruz River, July 30, 1937, E. D. Ball; 1, Patagonia Mts., Aug. 20, 1940, D. J. and J. N. Knull; 1, Phoenix, Sept. 14, 1937, 1, Nov. 10, 1938, Christensen; 2, Chiricahua Mts., Sept. 14, 1938, D. J. and J. N. Knull and 2, Roosevelt Dam, Oct. 26, 1930. (Texas) 11, Concan, July 6, 1936, D. R. Lindsay; 19, Concan, July 6, 1936, R. H. Beamer; 2, Val Verde Co., June 28, 1940, D. J. and J. N. Knull; 1, Uvalde Co., June 26, 1940, D. J. and J. N. Knull; 1, Ft. Stockton, May 31, 1937, D. J. and J. N. Knull; 1, Davis Mts., June 2, 1937, D. J. and J. N. Knull and 2, Medina Co., June 24, 1940, D. J. and J. N. Knull.

Host Plants: Ball writes (1932) "—a few nymphs and many adults were taken on the Water-Wally (*Baccharis glutinosa*) which grows so abundantly in the washes in Arizona." Other records on specimens examined were white clover and willow at Tucson, Arizona, and peach foliage and *Amaranthus* sp. in Bexar Co., Texas.

Comparative Notes: This species varies considerably in color—from almost black in southern California to light brown in southern Texas. In some few cases the face becomes reddish and it resembles *irroratus* somewhat, but the darkness of *irroratus* is due to dark dots—that of *loricatus* is a cloudiness. In Texas this species resembles *albifrons* but can be easily separated by the male genitalia.

One male cotype of *irroratus*, with a reddish face, collected at Tijuana, Mex., June 15, 1908, proved to be this species. Dr. Ball had already realized this and had so placed it in his collection. Osborn (1921) in listing *loricatus* from Florida was evidently referring to *albifrons*.

19. *Scaphytopius (Cloanthanus) pennatus* Hepner

Scaphytopius (Cloanthanus) pennatus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 90, 1946.

Resembles *loricatus* but slightly smaller, larger markings on crown and with wing-like processes at apex of aedeagus. Length: female 4 mm., male 3.8 mm.

Color: Crown dark brown to fuscous, except for light markings as follows: narrow line along anterior margin, wedge, two pairs of large spots forming an incomplete band before eyes, a pair of large spots at base next median suture and a smaller pair next eyes. Pronotum same color as crown with vittae usually distinct. Scutellum yellow to brown with typical light markings usually distinct. Face yellow with a few dark spots along lateral margins of genae and in area of sharksmouth; vitta behind eye sometimes faintly indicated. Forewing semihyaline fulvous with brown veins and irroration throughout, except for light aeroles.

Structural Characteristics: Crown about one and two-thirds as long as width between eyes, slightly convex on each side of a bluntly pointed apex. Pronotum less than three-fourths as long as crown, about three times as wide as length at middle. Clypeus about twice as long as width at ocelli, margins slightly concave near base of antennae. Face broadly convex in lateral view, except for slight concavity between anterior margin of eyes. Forewing with typical venation in clavus, several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin rounded to a blunt point; anterior margin concave on each side of a broad, rounded median lobe. Plates relatively broad near base, apical portion short and slender. Aedeagus roughly "L"-shaped, shaft almost parallel margined to a pair of wing-like processes at apex; base almost as long as shaft. Styles about twice as long as greatest width, almost parallel margined to lobe on outer margin before finger-like process on apical third.

Last ventral segment of female slightly less than twice as wide as length at middle, lateral margins slightly convex; posterior margin slightly produced to a broad, oval median lobe.

Types: Holotype ♂, allotype ♀, Brownsville, Texas, July 3, 1938, R. H. Beamer, in the Snow Entomological Collections. Paratypes as follows: (Texas) 1 ♂, Hidalgo Co., July 28, 1928, A. M. James; 1 pr., Cameron Co., Aug. 3, 1928, L. D. Beamer; 1 ♀, Cameron Co., Aug. 3, 1928, R. H. Beamer; 1 ♂, Brownsville, July 4, 1938, Jean Russell; 1 ♂, Brownsville, June 29, 1938, R. H. Beamer; 1 ♂, Brownsville, June 29, 1938, R. I. Sailer.

Host Plants: No host plant is known.

Comparative Notes: This species is apparently restricted to southern Texas. It is nearest *loricatus*, but has more distinct spots on crown and wing-like processes at apex of aedeagus.

20. *Scaphytopius (Cloanthanus) flavifrons* Hepner

Scaphytopius (Cloanthanus) flavifrons, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 91, 1946.

Resembling *pennatus* but broader and with longer apical processes at apex of aedeagus. Length: female 4 mm., male 3.8 mm.

Color: Crown dark brown with light marks as follows: wedge, two spots on each side of wedge along anterior margin, the one nearest eye smallest; a spot on each side of median suture on disc; a large spot on each side of median suture and a smaller one next each eye on posterior margin. Pronotum light brown with many fuscous dots throughout; typical light vittae indicated. Scutellum ivory to yellow with dark color restricted primarily to basal half. Face bright yellow, sometimes flecked on clypeus and outer margins of genae; much lighter than venter. Forewings translucent brown and white, the white primarily restricted to aeroles in the male; darkest on outer anteapical cell and adjacent area of costa.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, margins convex on each side of rounded apex. Pronotum about three-fourths length of crown, about two and one-half times as wide as length at middle and four and one-half times length behind eyes. Clypeus about twice as long as width at ocelli, slightly sinuate at antennae. Clypellus broadest near apex. Face distinctly convex in lateral view. Forewing with ten to twelve recurved veins to costa and often extra cross-veins in clavus.

Genitalia: Valve about as long as greatest width, posterior margin distinctly convex on each side of bluntly-pointed apex; anterior margin with long, slender, median lobe. Aedeagus roughly "L"-shaped. dorsal part broader but slightly shorter, shaft slightly curved near base, a pair of pointed apical processes, each about two-fifths length of shaft. Styles about two and one-half times basal width, distinct lobe on outer margin before outwardly projecting, finger-like, apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margins convex; posterior margin convex, slightly lobed at middle.

Types: Holotype ♂, Brownsville, Texas, May 25, 1939, D. J. and J. N. Knull, in the Knull collection, Ohio State University, Columbus, Ohio. Allotype ♀, Brownsville, Texas, Dec. 29, 1945, R. H. Beamer, in the Snow Entomological Collections. 1 ♀ paratype, Cameron Co., Texas, Aug. 3, 1938, R. H. Beamer.

Host Plants: No host plant is known.

Comparative Notes: This species is apparently restricted to the extreme southern part of Texas and is relatively rare. Its broadness and distinct genitalia separate it from any other species in the area.

21. *Scaphytopius (Cloanthanus) anisacanus* (Ball)

Nasutoides anisacanus, Ball, E. D., Can. Ent., LXIII, p. 222, 1931.

Resembles *loricatus* but larger, with a different pattern on crown and with long aedeagus and small paraphyses. Length: female 4.5 mm., male 4.5 mm.

Color: Crown with area between eyes ivory with brown irrorations, irregular brown markings around wedge and usually dark lines connecting these two dark areas; this leaves a more or less complete light band before the eyes and the remainder of crown consisting primarily of alternating thin light and dark irregular lines. Pronotum milky with fuscous irrorations excepting typical light lines. Scutellum brown with typical light markings. Face creamy yellow with apex of clypellus black and sometimes light markings on clypeus and a few marks behind eye.

Structural Characteristics: Crown about one and two-thirds as long as width between eyes, slightly concave on disc, margins slightly convex to a bluntly-pointed apex. Pronotum almost three-fourths as long as crown, two and one-half times as wide as length at middle and about four and one-half times length behind eye. Clypeus over twice as long as width at ocelli, slightly sinuate near base of antennae. Clypellus broadest near apex. Face almost straight in lateral view. Forewing with vein-like markings in brachial cell and about eleven recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin oval, with a small apical lobe; anterior margin somewhat concave on each side of median lobe. Paraphyses small and short, much shorter than shaft of aedeagus. Aedeagus about as long as plates, evenly narrowed to sharp curve near outer third; apical third almost parallel margined to a pair of small, slender apical processes. Styles over twice as long as greatest width, narrowest near middle, broadly rounded on outer margin to a short, outwardly projecting, apical process.

Last ventral segment of female slightly less than twice as wide as length at middle, lateral margins slightly convex; posterior margin

lobed on each side and small lobes on each side of a small median notch.

Types: Holotype ♀, allotype ♂, Sabino Canyon, Ariz., June 28, 1930, E. D. Ball, in the National Museum, Washington, D. C. 1 pair of paratypes on hand—Santa Catalina Mts., Ariz., July 17, 1930, E. D. Ball.

Additional Material Studied: Babaquivari Mts., Ariz.

Host Plants: Ball (1932) writes "—types together with the nymphs were taken on the mint-like plant (*Anisacanthus thurberi*) near Tucson, Arizona."

Comparative Notes: This is a relatively large species, almost covered with vermiculations. The long, curved aedeagus with tiny paraphyses is distinct and unlike any other species.

22. *Scaphytopius (Cloanthanus) contractus* Hepner

Scaphytopius (Cloanthanus) contractus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 92, 1946.

Resembles *loricatus*, but lighter in color, shorter crown and small paraphyses. Length: female 4.1 mm., male 3.8 mm.

Color: Crown white with an irregular, broad band across middle and a few thin lines on each side of wedge, yellow to brown. Pronotum a dark greenish-fulvous with light vittae distinct and sometimes irregularly bordered with dark dots. Scutellum same color as pronotum, or slightly lighter, with light markings distinct. Face yellow, narrow white line along margin between ocelli; slightly tawny behind eye, except for short, faint vitta; apex of clypellus black.

Structural Characteristics: Crown about one and two-thirds as long as width between eyes, lateral margins convex on each side of bluntly pointed apex. Pronotum only slightly shorter than crown, two and one-half times as wide as length at middle and five times as wide as length behind eyes. Clypeus about twice as long as width between ocelli and, except for slight sinuation at antennae, evenly narrowed to clypellus. Face convex in lateral view. Forewings with vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin oval; anterior margin concave on each side of a blunt, narrow, median lobe. Plates relatively slender, broadest on basal third. Small, short paraphyses, barely extending to apex of valve. Aedeagus

almost parallel-margined throughout, consisting of a basal, stem-like part, a short, simple, slightly curved shaft and an apical part about as long as basal part but curved at a right angle on middle. Styles somewhat over twice as long as basal width, "dog-legged" and almost parallel margined on middle, slightly lobed on outer margin at apical fourth before finger-like apical process.

Last ventral segment of female slightly less than twice as wide as length at middle, lateral margins slightly concave, posterior margin produced at middle with a very shallow median notch.

Types: Holotype ♂, allotype ♀, and 1 ♀ paratype, Brownsville, Texas, June 29, 1938, R. H. Beamer, in the Snow Entomological Collections. 1 ♂ paratype, Brownsville, Texas, June 29, 1938, L. W. Hepner.

Host Plants: The host plant is not known.

Comparative Notes: This species, evidently restricted to southern Texas, is quite distinctive with its yellow face and short aedeagus with short, small genital paraphyses

23. *Scaphytopius (Cloanthanus) brunneus* Hepner

Scaphytopius (Cloanthanus) brunneus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 98, 1946.

Resembles *loricatus* but lighter, darker on lateral margins of face and with small genital paraphyses. Length: female 4 mm., male 3.7 mm.

Color: Crown brown with light markings as follows: narrow line along anterior margin; wedge and a pair of oblique lines on each side; three pairs of markings on a band before eyes, the median pair longest; two pairs of spots on posterior margin, one next each eye and one on each side of median suture, the median pair often split anteriorly. Pronotum about same color as crown with typical vittae evident. Scutellum brown with typical light markings. Clypeus, lorae and clypellus yellow to fulvous with white sharksmouth; irregular area along margin between eyes and irregular light markings in area of sharksmouth, brown; apex of clypellus dark. Genae with numerous dark irrorations, vitta behind eye irregular but distinct. Forewing semihyaline fulvous with milky aeroles and brown irrorations; veins brown, becoming fuscous on apex and costa.

Structural Characteristics: Crown about one and one-third times as long as width between eyes, longer in female, anterior margin almost straight on each side of a blunt apex; wedge about one-fourth length of crown. Pronotum about three-fourths as long as

crown, shorter in female, about two and one-half times as wide as length at middle and about four times as wide as length behind eyes. Clypeus over twice as long as width at ocelli, practically no constriction at antennae. Clypeus relatively slender and somewhat enlarged near apex. Face in lateral view almost straight in male, definitely concave between anterior margin of eyes in female. Forewing with several vein-like marks in brachial cell and eight or nine recurved veins to costa.

Genitalia: Valve somewhat shorter than greatest width; posterior margin convex on each side of a bluntly pointed apex; anterior margin with relatively long median lobe. Plates short and very broad near base. Aedeagus in lateral view, broad, roughly "U"-shaped, dorsal part shortest, shaft broad and short, enlarged at apex. Paraphyses very small and short, hardly reaching to apex of shaft of aedeagus. Styles about three times as long as basal width, relatively large lobe on outer margin just before slender, finger-like apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margin convex, posterior margin with small lobe at each side and broad median lobe.

Types: Holotype ♂, allotype ♀ and a pair of paratypes, Paradise Key, Fla., April 9, 1921, D. M. DeLong, in the DeLong collection, Ohio State University, Columbus, Ohio. Additional paratypes as follows: 2 ♀ ♀, Key Largo, Fla., July 19, 1939, R. H. Beamer.

Host Plants: No host plant is known.

Comparative Notes: The only species with which this might be confused in southern Florida is *albifrons*, from which it may be separated by its marginal infuscation on face, and small paraphyses.

24. *Scaphytopius (Cloanthanus) fuscifrons* (Van Duzee)

Platymetopius fuscifrons, Van Duzee, Bull. Buffalo Soc. Nat. Hist., V, p. 206, 1894.

Platymetopius abruptus, Ball, E. D., Ent. News, XX, p. 165, 1909.

Resembling *frontalis*, but with shorter crown, face and crown entirely dark and with plates of male very short. Length: female 4.5 mm., male 4 mm.

Color: Crown fuscous and white mottled in male, lighter in female, usually darkest on each side of median suture. Pronotum same color as crown with irregular vittae usually evident. Scutellum dark, orange spot near each basal corner, typical light markings distinct. Face in male fuscous with small white spots through-

out, darkest on outer margin of genae, female usually lighter; sharksmouth small in both; white vitta behind eye and two shorter vittae before eye, distinct. Forewing of male fuscous with semi-hyaline milky spots throughout, larger in costal area; female lighter, usually semihyaline milky with brown veins, darkest in apical cells. Occasionally females are found which are the same color as the males but usually they are much lighter.

Structural Characteristics: Crown about one and one-third as long as distance between eyes, anterior margin slightly convex on each side of a blunt apex; wedge about one-third length of crown. Pronotum about four-fifths as long as crown, over twice as wide as length at middle and four times length behind eyes. Clypeus less than twice as long as width between ocelli, only slightly narrowed, if at all, at antennae. Clypellus enlarged at both ends. Face convex in lateral view, more so in the male. Forewing with venation typical, about six vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve over three-fourths as long as greatest width, broadly oval on posterior margin; anterior margin broadly produced on median third. Plates truncate, extending only slightly beyond styles. Paraphyses broad, extending well beyond plates, apices spear-like. Aedeagus about as long as width at base, evenly narrowed to a flange-like, broadly pointed apex. Styles over twice as long as basal width, slightly constricted on basal third, outer margin rounded to finger-like process on apical third.

Last ventral segment of female almost three times as wide as length at middle, lateral margins convex, posterior margin lobed on outer third, median third concave with relatively long, parallel-sided notch at middle.

Types: Lectotype ♂, "Arizona," in Iowa State College collection, Ames, Iowa, lectoallotype ♀, same data, here designated. Both of these were on hand for study.

Additional Material Studied: (California) San Jacinto Mts., Topango Canyon, Arroyo Seco River, Alpine, Eureka, Beaumont, Gibson and Pine Valley. (Arizona) Huachucua Mts., Oak Creek Canyon, Chiricahua Mts., Santa Rita Mts., Flagstaff, Glenn Oaks, Santa Catalina Mts. and Pinal Mts. (Utah) Alton and Logan Canyon. (Colorado) Rabbit Ears Pass. (Wyoming) Grand Teton National Park and Yellowstone Park.

Host Plants: Ball (1932) writes "—apparently strictly confined to the buckbrush. The writer has taken it commonly in Utah and

Arizona on *Ceanothus fedleri*." One specimen was taken in 1938 by R. H. Beamer on *Amorpha frutiosa* in Huachucua Mts., Arizona, but this may have been merely resting there.

Comparative Notes: This species, with its two subspecies, are distinctly different from other species in the shape of the external genitalia. References to this species from east of the Rockies probably refer to *nigrifrons* or *magdalensis*.

25. *Scaphytopius (Cloanthanus) fuscifrons compactus* (Ball)

Platymetopus compactus, Ball, E D, Ent News, XXVII, p 176, 1916.

Resembles *fuscifrons* but with definite light band on crown before eyes. Length: female 4.7 mm., male 4.5 mm.

Color: Crown black with yellow irrorations except for irregular light band before eyes, wedge, and a spot on posterior margin next each eye; often a pair of oblique light marks on base about half way between median suture and eyes. Pronotum semihyaline milky with heavy black irrorations, heaviest near posterior margin, lightest on anterior and lateral margins, often yellow area behind each eye; vittae obscure or faintly indicated near lateral margins. Scutellum with basal half brown with ivory or yellow spots in each corner and irregular spots throughout; apical half usually ivory to yellow with few dark markings, if any. The scutellum varies considerably, but is usually much lighter than in *fuscifrons*. Forewing semihyaline white, with heavy black markings, especially on disc of outer anteapical and adjoining area of costa and in apical cells. The amount of black may vary from almost none in specimens from Colorado and Wyoming to almost entire in specimens from the mountains of California. Face chocolate brown to black, lightest on lorae, with small, light dots throughout; short light vitta behind eye, one below ocellus and another at base of antennae; sharksmouth short but distinct; basal margin of clypeus narrowly lined with light.

Structural Characteristics: Crown only slightly longer at middle than width between eyes; wedge about one-third length of crown. Pronotum about three-fourths as long as crown, almost three times as wide as length at middle and four and one-half times length behind eyes. Clypeus about twice as long as width at ocelli, slightly sinuate near base of antennae. Clypellus widest near apex. Face convex in lateral view. Forewing venation often obscured by dark markings.

Genitalia: Valve about four-fifths as long as greatest width, posterior margin broadly rounded; anterior margin slightly concave on

each side of a slender median process. Plates short, evenly rounded on outer margins. Paraphyses more or less parallel-margined to spearlike apices. Aedeagus about as long as basal width, apex flange-like and bluntly pointed. Styles reaching almost to apex of plates, about two and one-half times as long as greatest width, sinuate near basal third, broadly lobed on outer margin to a finger-like process on apical third, somewhat more slender than in *fuscifrons*.

Last ventral segment of female almost three times as wide as greatest length, lateral margins convex, posterior margin with deep, "V"-shaped, median suture and a small concavity on each side.

Types: Lectotype ♀, Dunsmuir, Calif., Aug. 13, 1912, E. D. Ball, here designated, in the National Museum, Washington, D. C. Allotype ♂, Dunsmuir, Calif., June 29, 1935, R. H. Beamer, here designated, in the Snow Entomological Collections. Parallotype ♂ ♂ as follows: (California) 2, Towie, Aug. 20, 1938, R. I. Sailer; 6, Towie, Aug. 20, 1938, R. H. Beamer; 1, Echo, Aug. 10, 1940, R. H. Beamer and 1, Yosemite National Park, Aug. 1, 1940, R. H. Beamer. (Wyoming) 1, Grand Teton National Park, Aug. 18, 1931, John Nottingham. (Montana) 2, Haugan, Aug. 9, 1931, R. H. Beamer and 2, Haugan, Aug. 9, 1931, John Nottingham.

Host Plants: Ball says (1932) "—taken by the writer on a tall species of Buckthorn (*Ceanothus* sp.) in northern California and has since been taken in small numbers in the higher mountains of Arizona." However, Ball may have confused this subspecies with the following subspecies, which it resembles.

Comparative Notes: This subspecies evidently replaces *fuscifrons* at high altitudes.

26. *Scaphytopius (Cloanthanus) fuscifrons minutus* Hepner

Scaphytopius (Cloanthanus) fuscifrons subsp. *minutus*, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 94, 1946.

Resembles *compactus*, but smaller, with basal area of crown light and with distinct light band across forewing. Length: female 4 mm., male 4 mm.

Color: Crown brown except for ivory to yellow markings as follows: wedge, narrow area next pronotum, more or less distinct band before eyes, and narrow line along anterior margin. Pronotum brown irrorate with fulvous, more or less broad milky area along posterior margin; vittae indistinct or absent, except near lateral margins. Scutellum ivory to yellow, large brown spot near each basal corner and sometimes indistinct irrorations between these.

Face reddish-brown, approaching black on lateral margins of genae and near sharksmouth; small, light irrorations throughout, larger light spot along margin of genae next lower part of lorae, on disc of lorae sclerites and on disc of clypeus near apex; a light vitta behind eye, a shorter one near ocellus and another near base of antennae; sharksmouth small but distinct; basal margin light. Forewing semihyaline milky with black markings on basal half and in anteapical and apical cells, leaving a distinct light band across second cross-vein and across apices of anteapical cells, giving a distinct two-banded appearance, more distinct in males, which are usually slightly darker; veins dark throughout.

Structural Characteristics: Crown about one and one-third as long as width between eyes, margins slightly convex; wedge about one-fourth length of crown. Pronotum about three-fourths as long as crown, about three times as wide as length at middle and four and one-half times length behind eyes. Clypeus almost twice as long as distance between ocelli, only slightly sinuate, if any, at antennae. Clypellus widest near apex. Face convex in lateral view, although slightly concave between anterior margin of eyes. Forewing with claval veins joining or almost joining; eight or ten more or less distinct cross-veinlike marks in brachial cell and about twelve recurved veins to costa.

Genitalia: Valve about four-fifths as long as greatest width, oval on median half of anterior margin, broadly truncate on median half of anterior margin. Plates short, bluntly pointed. Paraphyses only slightly broadened toward sharp apices. Aedeagus short, smallest at base, broadest just before blunt apex. Styles about two and one-half times as long as basal width, sinuate on basal fourth, slightly lobed on outer third to a parallel margined apical process.

Last ventral segment of female about three times as wide as greatest length; irregularly lobed on each side of a relatively long, parallel-margined median notch.

Types: Holotype ♂, allotype ♀, and 6 ♀ and 7 ♂ paratypes, Miami, Arizona, Aug. 6, 1941, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (Arizona) 1 ♂, Yarnell Hts., Oct. 8, 1929, 1 ♀, July 21, 1929, E. D. Ball; 4 ♀ ♀, 2 ♂ ♂, Pinal Mts., July 7, 1936, E. D. Ball; 1 ♀, Santa Catalina Mts., July 30, 1930, E. D. Ball; 1 ♂, Santa Rita Mts., June 16, 1933, P. W. Oman and 1 pr., Douglas, June 10, 1936, E. D.

Ball. (Texas) 1 ♀, Concan, July 6, 1936, R. H. Beamer and 1 ♂, Chisos Mts., Sept. 19, 1938, D. J. and J. N. Knull.

Host Plants: Ball's reference (1932) to *compactus* in Arizona probably referred to this subspecies, as some of his specimens were labelled "*Ceonothus*."

Comparative Notes: The specimens from Texas are somewhat smaller than those from Arizona, but appear to be the same thing. It is easily separated from *compactus* by its smaller size and more light color on crown and face.

27. *Scaphytopius (Cloanthanus) dodonanus* (Ball)

Nasutoides dodonanus, Ball, E. D., Can. Ent., LXIII, p. 225, 1931.

Resembling *fulvus* but with longer crown, with genital paraphyses united basally and western in distribution. Length: female 4.2 mm., male 4 mm.

Color: Crown fulvous to brown with ivory markings as follows: wedge, three pairs of spots across crown in front of eyes, a pair of spots near median suture at base and a pair of small spots on posterior margin next eyes. Pronotum yellow-fulvous, vittae usually at least faintly indicated. Scutellum yellow to orange with typical markings ivory. Face creamy-yellow throughout. Forewings semihyaline-fulvous with a few scattered aeroles; veins concolorous except in apical cells and costa, where they are brown.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, bluntly pointed, wedge only about one-fifth length of crown. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and about five times length behind eyes. Clypeus about twice as long as width at ocelli, more or less evenly narrowed to apex. Clypellus widest near apex. Face convex in lateral view except near apex, where it is slightly concave. Forewing with several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about as long as greatest width, rounded on posterior margin, concave on each side of median lobe on anterior margin. Plates slender, over twice as long as greatest width, broadest on basal fourth. Paraphyses loosely joined on basal third, broadest on apical third, constricted on apical fifth and enlarged again before sharp apex. Aedeagus inserted where paraphyses separate, roughly an inverted "T"-shaped, with ventral process short and stout, dorsal process longer and more slender and shaft slightly nar-

rowing to a pair of erect processes at apex. Styles about three times as long as basal width, almost parallel-margined on basal three-fourths, except for slight constriction near middle, slightly lobed on outer margin before outwardly-projecting, finger-like, apical process.

Last ventral segment of female about twice as wide as length at middle, posterior margin straight and slightly narrower than at widest point.

Types: Holotype ♀, allotype ♂, Tucson, Arizona, June 28, 1930, E. D. Ball, in the National Museum, Washington, D. C. One pair of paratypes, Tucson, Arizona, Sept. 22, 1929, E. D. Ball, on hand for study.

Additional Material Studied: (Arizona) Sabino Canyon, Santa Catalina Mts., Santa Cruz River, Baboquivari Mts. and La Osa River.

Host Plants: Ball (1932) writes "Yellow nymphs and brownish yellow adults were taken exclusively on the shrub *Dodonaea viscosa* var. *angustifolia* in Arizona."

Comparative Notes: Some specimens are gray with darker veins and markings, especially in specimens collected in October and November. The male genitalia is unlike any other species examined.

28. *Scaphytopius (Cloanthanus) celtidus* (Ball)

Nanotoides celtidus, Ball, E. D., Can. Ent. LXIII, p. 224, 1931.

Somewhat resembling *anisacanus* but smaller, lighter in color, with area of crown next pronotum with few or no markings and with distinctly different genitalia. Length: female 4.5, male 4 mm.

Color: Crown white except for indistinct fuscous band between anterior part of eyes, area around wedge, a few lines on disc and usually a few small spots on posterior margin next eye. Pronotum semihyaline milky with scattered brown to fuscous dots, darkest along anterior and near posterior margin. Scutellum white to yellow, except for indistinct darker markings near apex and sometimes near each basal corner. Face ivory with brown vermiculations throughout; sharksmouth and vitta behind eye, distinct. Forewing semihyaline milky with numerous scattered fuscous vermiculations, usually dark area on costa and adjoining anteapical cell opposite apex of clavus. In some dark specimens, the vermiculations are fused to form large dark blotches throughout wing.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, margins slightly convex on each side

of blunt apex; wedge about one-fourth length of crown. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and about four and one-half times length behind eyes. Clypeus about twice as long as width at ocelli in female, slightly shorter in male, slightly sinuate near antennae. Clypellus largest near base. Face in lateral view almost straight in male, slightly concave between anterior margin of eyes in female. Forewing with venation typical with numerous markings in brachial cell and about ten recurved veins to costa.

Genitalia: Valve roughly triangular, posterior margin somewhat convex on each side of a bluntly pointed apex; anterior margin with broad median lobe. Plates short, broad near base. Paraphyses joined on basal three-fourths, apical fourth slightly bulbous before sharp apices. Aedeagus in lateral view with broad dorsal portion, shaft "J"-shaped, almost parallel-margined, and with a pair of slender apical processes about as long as shaft; in ventral view the apical processes extend laterally. Styles about two and one-half times as long as basal width, lobed on outer margin just before curved, outwardly projecting, finger-like apical processes.

Last ventral segment of female slightly more than half as long as greatest width, lateral margins slightly convex; posterior margin with small lobe near outer margin and a broad median lobe notched at middle.

Types: Holotype ♀, allotype ♂, Tucson, Arizona, July 24, 1920, E. D. Ball, in the National Museum, Washington, D. C. One pair of paratypes, Tucson, Arizona, June 28, 1930, E. D. Ball, were on hand for study.

Additional Material Studied: (Arizona) Lewis Spgs., Santa Rita Mts., Sabino Canyon.

Host Plants: Ball (1932) writes "—strictly confined, both nymphs and adults, to the evergreen desert hackberry (*Celtis pallida*)."

Comparative Notes: The distinctively marked crown and distinct male genitalia easily separate this species from any other.

29. *Scaphytopius (Cloanthanus) californiensis* Hepner

Scaphytopius (Cloanthanus) californiensis, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 95, 1946.

Resembles *irroratus* but lighter, larger, with larger spots on crown, and with short genital paraphyses. Length: female 4.2 mm., male 3.8 mm.

Color: Crown with fuscous areas around wedge and between

anterior parts of eyes, remainder fulvous except for following light markings: wedge, thin line along anterior margin, three pairs of spots before eyes, the median pair greatly elongated and joining a pair of spots on posterior margin next median suture. Pronotum milky semihyaline to fulvous with irrorations throughout, vittae usually indicated. Scutellum orange with typical light markings usually lined with fuscous. Face fulvous with brown irrorations throughout, usually slightly darker along lateral margins and lightest on lorae; sharksmouth and vitta behind eye usually fairly distinct. Forewing semihyaline milky to pale fulvous with veins and numerous dots, forming aeroles throughout; dark area on costa and adjoining anteapical cell.

Structural Characteristics: Crown of male about one and one-half times as long as width between eyes, slightly longer in female; margins slightly convex in male, almost straight in female. Pronotum about three-fourths as long as crown, almost two and one-half times as wide as length at middle. Clypeus slightly more than twice as long as width at ocelli, slightly sinuate near antennae. Clypellus relatively slender, widest near apex. Face in lateral view convex, slightly concave between anterior margin of eyes in female. Forewing with venation typical, about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin convex on each side of a bluntly pointed apex; anterior margin with a relatively long median lobe. Paraphyses joined on basal two-thirds, apices free and sharply pointed. Shaft of aedeagus short, curved, only slightly narrower at apex than at base. Styles only about twice as long as basal width, distinct lobe on outer margin just before outward-projecting, finger-like, apical process.

Last ventral segment of female slightly over half as long as greatest width, lateral margins slightly converging; posterior margin straight with exception of small, broad, median lobe.

Types: Holotype ♂, allotype ♀, and 21 ♀ and 10 ♂ paratypes, Ventura, California, July 20, 1933, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (California) 2 ♂ ♂, Anza, July 29, 1938, R. H. Beamer; 1 pair San Gabriel Canyon, July 2, 1935, R. H. Beamer; 1 ♀, Mint Canyon, July 6, 1933, R. H. Beamer; 1 ♂, Mint Canyon, June 7, 1935, P. W. Oman; 2 ♀ ♀, 1 ♂, Alpine, July 5, 1931, E. D. Ball; 1 ♀, Three Rivers, June 9, 1935, P. W. Oman; 1 ♀, Fresno, May 20, 1898; 3 ♀ ♀, Monterey, July 22, 1935, R. H. Beamer; 2 ♀ ♀, Nipomo, July 24, 1935, R. H. Beamer; 1 pair Lompoc, Aug. 9, 1938, R. H.

Beamer; 1 ♀, Lompoc, Aug. 9, 1938, R. I. Sailer; 3 ♀ ♀, 1 ♂, Beaumont, June 12, 1931, E. D. Ball; 1 ♀, 2 ♂ ♂, Ontario, Oct. 21, 1938, Christensen; 2 pairs, Hemet, Oct. 26, 1938, Christensen; 1 ♀, Topango Canyon, Aug. 5, 1938, L. W. Hepner; 3 ♀ ♀, 7 ♂ ♂, Topango Canyon, Aug. 5, 1938, R. H. Beamer; 1 ♀, Santa Ana Canyon, July 30, 1932, R. H. Beamer; 1 ♂, Los Angeles, Uhler; 8 ♀ ♀, 2 ♂ ♂, Claremont, July 29, 1935; R. H. Beamer; 1 ♂, Claremont, July 29, 1935, Jack Beamer; 1 ♀, Palm City, Aug. 7, 1935, R. H. Beamer; 1 ♂, Escondido, July 15, 1941, R. H. Beamer; 1 ♀, 2 ♂ ♂, La Jolla, July 13, 1941, R. H. Beamer; 4 ♀ ♀, 2 ♂ ♂, San Diego, Aug. 7, 1935, 2 ♀ ♀, July 24, 1941, R. H. Beamer; 9 ♀ ♀, 3 ♂ ♂, San Diego, July 5, 1931, E. D. Ball; 1 ♀, July 17, 1915, 1 ♀, Aug. 29, 1915, L. A. Titus; 1 ♂, Arroyo Seco River, Aug. 8, 1938, R. H. Beamer; 1 ♀, Strawberry, Aug. 8, 1929, R. H. Beamer; 2 pairs, Long Beach, July 4, 1931, E. D. Ball and 1 ♀, Lindsay Hts., Dec. 19, 1938, E. A. McGregor.

Host Plants: Specimens were examined which had been collected on *Arctostaphylea glauca* and *A. zacaensis*, but these plants may have been only a resting place for them.

Comparative Notes: This species is restricted to southern California, somewhat resembles *nogalinus*, but has a longer, sharper, darker crown and quite different genitalia.

30. *Scaphytopius (Cloanthanus) diabolus* (Van Duzee)

Platymetopius diabolus, Van Duzee, E. P., Proc. Calif. Acad. Sci., XIV, p. 418, 1925.

Resembles *frontalis*, but lighter colored, with longer crown, more distinct band before eyes and western in distribution. Length: female 4.5 mm., male 4 mm.

Color: Crown black with ivory or white markings as follows: thin line along anterior margin; wedge and oblique mark on each side; irregular, almost complete band before eyes; and irregular markings in an area along basal margin, largest in female. Pronotum gray with irregular black irrorations, much lighter on lateral and anterior margins. Scutellum black with typical light markings. Clypeus light brown on apical two-thirds, darker on base in area of small sharksmouth. Lorae and clypellus light brown except for black tip of clypellus. Genae mottled brown to fuscous with white vitta behind eye and shorter one near ocellus, distinct. Forewing semi-hyaline white with irregular black markings throughout, heaviest on costa and in anteapical cell opposite apex of clavus.

Structural Characteristics: Crown about one and one-third times as long as width between eyes, anterior margin slightly convex on each side of a bluntly pointed apex; wedge very short. Pronotum slightly over two and one-half times as wide as length at middle and four times length behind eye. Clypeus about twice as long as width at ocelli, only slightly sinuate, if at all, at antennae; depression on each side at end of sharksmouth. Clypellus rather slender and slightly enlarged near apex. Face in lateral view straight in male, slightly concave between anterior margin of eyes in female. Forewing with outer claval vein approaching or touching second claval vein at cross-vein, often extra cross-veins in clavus; brachial cell with many vein-like marks and costal area with ten or eleven recurved veins.

Genitalia: Valve about one and one-third as wide as length at middle, posterior margin somewhat convex on each side of pointed apex; anterior margin with short, broad median lobe. Paraphyses broad, extending well beyond plates, almost parallel-margined to sharp apex. Aedeagus in ventral view short, apices sagittate. Styles long, about three times as long as basal width, constricted on basal fourth, outer margin rounded just beyond middle to a long, bluntly pointed, apical process.

Last ventral segment of female slightly less than twice as wide as length at middle, evenly rounded on latero-posterior margin to a distinct median notch on posterior margin.

Types: Holotype ♂, No. 1788, allotype ♀, No. 1789, Mt. Diablo, Calif., July 14, 1916, E. P. Van Duzee, in the Museum of the California Academy of Science, San Francisco, Calif.

Material Studied: (California) Mt. Shasta, Yosemite Valley, Weed, La Jolla, Lone Pine, Mariposa, Colfax, Doyle, Beaumont, Chilcoot and Ontario. (Oregon) Grants Pass, Spray, Medford and Ashland. (Washington) Satus Pass and Toppinish. (Arizona) Grand Canyon, Jerome, Prescott and Granite Dell. (Nevada) "Nev." March, 1936. (Utah) Provo, Logan Canyon and Heber City. (Idaho) Ruhl. (Colorado) Macedonia and Poudre River Canyon.

Host Plants: Ball (1932) writes of *nasutus*, evidently referring to *diabolus*, "—taken in abundance, nymphs and adults, on the cliff rose (*Cowania stansburiana*) in Utah and Arizona."

Comparative Notes: The male of *nasutus* was probably this species, but since it was described in a paper on Jamaica insects, the

female from that island is designated holotype for that species, leaving *diabolus*, described from California, to include the specimens originally placed in *nasutus*. The color of forewing varies from white with scattered black vermiculations, to almost entirely black.

31. *Scaphytopius (Cloanthanus) pallidiscutus* Hepner

Scaphytopius (Cloanthanus) pallidiscutus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 96, 1936.

Resembles *diabolus* but larger, with a longer crown, scutellum lighter colored, and with longer aedeagus. Length: female 4.5 mm., male 4.5 mm.

Color: Crown black with white marks as follows: a thin line along anterior margin; wedge and a line on each side parallel to margin; an almost complete, broad irregular band before eyes; and two pairs of spots along posterior margin, one pair next eyes and another next median suture, basal fifth with black replaced by fulvous or brown except for a few lines. Pronotum gray with scattered dark spots; irregular light vittae usually faintly indicated. Scutellum light fulvous to brown with typical light markings; sometimes almost entirely ivory. Face evenly reddish-brown, mottled throughout, much more unicolorous than *diabolus*, except for fuscous tip of clypellus, irregular black markings below small sharksmouth, light vitta behind eye and shorter one near ocellus.

Structural Characteristics: Crown about one and two-thirds as long as width between eyes, almost straight margined on each side of a bluntly pointed apex; wedge about one-fifth length of crown. Pronotum about two-thirds as long as crown, about two and one-half times as wide as length at middle, and four and one-half times length behind eye. Clypeus over twice as long as width at ocelli, slightly sinuate at antennae; a depression, almost parallel to basal margin, on each side before eye. Clypellus broadest just before apex. Face in lateral view concave between anterior margin of eyes. Forewing with two or three cross-veins connecting claval veins; usually ten or more marks or cross-veins in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about four-fifths as long as greatest width, posterior margin convex on each side of a bluntly pointed apex; anterior margin evenly rounded. Paraphysis almost twice as long as style, largest near base, almost parallel-margined to sharp apex, except for constriction near outer third. Shaft of aedeagus slender,

about one-half as long as styles, evenly narrowed to a pair of short, dorsal, apical processes. Styles almost four and one-half times as long as greatest width, slightly constricted on basal third, distinct lobe on outer margin before long, slender process on apical half.

Last ventral segment of female somewhat less than twice as wide as length at middle, slightly concave on lateral margins, then rounded to a small median notch at middle on posterior margin; more truncate than *diabolus*.

Types: Holotype ♂, allotype ♀, and 12 ♀ and 8 ♂ paratypes, Boulevard, California, July 26, 1938, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes from California as follows: 1 ♂, Santa Rosa, Aug. 16, 1938, R. H. Beamer; 3 ♀ ♀, Santa Cruz Mts., Aug. 13, 1938, R. I. Sailer; 1 ♀, Jamesburg, Aug. 11, 1938, R. H. Beamer; 1 ♀, Lockwood, July 24, 1935, R. H. Beamer; 1 ♀, Lompoc, Aug. 9, 1938, R. I. Sailer; 1 ♀, 2 ♂ ♂, Beaumont, June 12, 1931, E. D. Ball; 1 ♂, Big Bear Lake, July 26, 1932, R. H. Beamer; 2 ♀ ♀, 1 ♂, Topango Canyon, Aug. 5, 1938, R. I. Sailer; 1 ♀, Topango Canyon, Aug. 5, 1938, L. W. Hepner; 1 ♀, Claremont, July 29, 1935, R. H. Beamer; 12 ♀ ♀, 13 ♂ ♂, Pine Flats Camp, Indio, July 12, 1941, R. H. Beamer; 1 ♀, Jacumba, July 17, 1940, R. H. Beamer; 7 ♀ ♀, 3 ♂ ♂, Campo, Aug. 10, 1935, R. H. Beamer and 3 ♀ ♀, Pine Valley, July 27, 1938, 1 ♀, July 18, 1941, R. H. Beamer.

Host Plants: Specimens have been collected in southern California from *Ceanothus greggii purplexans* and *C. cuneatus* and *Arctostaphylae pungens* and *A. glauca*, so it is possible that *Ceanothus* or *Arctostaphylae* is the host of this species.

Comparative Notes: This species is similar to *diabolus*, but can be separated easily by the lighter scutellum, lighter and more evenly colored face and the longer aedeagus of the male. The female last ventral segment of this species is more truncate than that of *diabolus*. This species is evidently restricted to California.

32. *Scaphytopius (Cloanthanus) fulvus* (Osborn)

Platymetopius fulvus, Osborn, Herbert, Rep't. of New York St. Entomologist (20th Report) p. 619, 1905.

Resembles *magdalenis*, but fulvous throughout and with parapses bifid. Length: female 5 mm., male 4.5 mm.

Color: Crown fulvous with lighter markings as follows: wedge; one or two pairs of dots between wedge and eye, a long mark on each side of median suture from near wedge to posterior margin and

another pair on posterior margin next eyes. Pronotum fulvous with light vittae sometimes faintly indicated. Scutellum fulvous with typical light markings. Face fulvous, usually lightest on clypeus, with relatively long sharksmouth faintly indicated. Forewing fulvous, veins only slightly darkened except near apex and on costa.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, anterior margin only slightly convex on each side of pointed apex; wedge about one-fourth length of crown. Pronotum somewhat shorter than crown, a little less than two and one-half times as wide as length at middle and about four times as wide as length behind eyes. Clypeus about twice as long as width at ocelli, almost evenly narrowed to apex. Clypellus relatively narrow and enlarged near apex. Face in lateral view almost straight in male, slightly concave between anterior margin of eyes in female. Forewing with typical venation, seven or eight recurved veins to costa.

Genitalia: Valve almost as long as greatest width; posterior margin only slightly convex on each side of a sharp apex, anterior margin with broad, short median lobe. Paraphyses narrow, about twice as long as styles, with slender lateral process on outer third. Aedeagus roughly "U"-shaped, dorsal part lighter and less heavily sclerotized, shaft almost parallel-margined to a very small dorsal process at apex. Styles about four times as long as greatest width, almost parallel-margined on basal three-fourths, only slightly lobed on outer margin to finger-like apical process.

Last ventral segment of female about one and one-half times as wide as length at middle, latero-posterior margin rounded to a small median lobe.

Types: Lectotype ♂, lectoallotype ♀, Cold Spr. Harbor, New York, August 18, 1904, H. Osborn, here designated, in Osborn Collection, Ohio State University, Columbus, Ohio. The original description gives Oyster Bay as the type locality, but Cold Spring Harbor is within Oyster Bay and in this case, these two localities are identical. One cotype was on hand for study.

Additional Material Studied: (Wisconsin) Grand Rapids. (Connecticut) New Haven. (Maryland) Ashton. (Virginia) Cape Henry (North Carolina) Walnut and Franklin.

Host Plants: Osborn (1904) writes "—beaten from pine and huckleberry—As all are adults it is impossible to determine the food plant with certainty though it seems likely that it is the huckle-

berry and that individuals taken from pines were resting accidentally on the trees." Ball (1932) writes "—found yellow nymphs swarming on Bayberry (*Myrica carolinensis*) at Woods Hole, Massachusetts, July 7, 1925, a few days later an immature adult that was determined as *fulvus* was taken from this spot."

Comparative Notes: This species, with its subspecies *collaris*, has genitalia which differ considerably from any other—the long, slender bifid paraphyses and the long, slender shaft of the aedeagus easily separate it from any other species. It has a relatively wide distribution, but from the small number of specimens, it seems to be relatively uncommon.

33. *Scaphytopius (Cloanthanus) fulvus collaris* (Sand. and DeLong)

Platymetopius collaris, Ann. Ent. Soc. Amer., XII, p. 282, 1919

Resembles *fulvus*, but with most of pronotum and basal half of scutellum dark brown and remainder of dorsum ivory to light fulvous. Length: female 5.3 mm., male 4.8 mm.

Color: Crown ivory to light fulvous; wedge and arcuate markings on disc often indicated. Pronotum brown, except for yellow to fulvous area on each lateral margin, slender median vitta, and dots throughout. Scutellum with basal half dark brown and apical half yellow to fulvous. Face completely yellow to fulvous and without irrorations. Forewings translucent pale fulvous, veins brown on apex and costal area.

Structural Characteristics: Crown about one and one-third as long as width between eyes, anterior margin straight to slightly convex on each side of bluntly pointed apex. Pronotum about as long as crown, two and one-half times as wide as length at middle and four times length behind eyes. Clypeus about twice as long as width at ocelli, slightly sinuate at antennae. Clypellus long and somewhat enlarged near apex. Face in lateral view almost straight in male, slightly concave between anterior margin of eyes in female. Forewing with typical venation; ten recurved veins to costa.

Genitalia: Male and female genitalia about the same as for *fulvus*.

Types: Holotype ♂, allotype ♀, Penfield, Clearfield Co., Pennsylvania, Aug. 24, 1918, Sanders, here designated, in the DeLong Collection, Ohio State University, Columbus, Ohio. The holotype was on hand for study.

Host Plants: The original description gives *Vaccinium* sp. as the plant from which the type material was taken.

Comparative Notes: This is apparently a rather rare species, as only the type specimen named above has been seen by the author. Except for color, it agrees with *fulvus* in almost every respect.

34. *Scaphytopius (Cloanthanus) frontalis* (Van Duzee)

Platymetopius frontalis, Van Duzee, E. P., Can. Ent., XXII, p. 112, 1890.

Resembles *loricatus*, but with lateral margins of face dark and with paraphyses. Length: female 4.1 mm., male 3.8 mm.

Color: Crown fuscous to black with light markings as follows: narrow line along anterior margin; wedge; a large irregular spot on margin before each eye and a smaller pair between these; two pairs of dots on posterior margin, one pair next eyes and another near median suture. The light spots are usually smaller on the male. Pronotum and scutellum about same color as crown with typical light markings. Clypeus yellow with brown markings near base, forming large sharksmouth and other irregular markings along basal margin. Clypellus and lorae yellow. Genae yellow mesially, infuscated behind eyes and along lateral margins, except for distinct white vitta behind eye; less distinct, short vitta near ocellus. Forewing semihyaline black, pale fulvous along veins; milky aeroles throughout.

Structural Characteristics: Crown about one and one-half times as long as width between ocelli, anterior margin slightly convex on each side of blunt apex; wedge about one-fourth length of crown. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and four times length behind eye. Clypeus about twice as long as width at ocelli, margins almost straight. Clypellus relatively slender, slightly broadened near base. Face in lateral view almost straight. Forewing with typical venation, several vein-like marks in brachial cell and nine or ten recurved veins to costa.

Genitalia: Valve roughly triangular, almost as long as greatest width, posterior margin convex on each side of a pointed apex; anterior margin with a wide, short, median lobe. Paraphysis long, slender, almost parallel-margined to a sharp apex. Shaft of aedeagus "L"-shaped, curved on basal two-fifths, almost parallel-margined to blunt apex. Styles about four times as long as basal width, large lobe on outer margin just before relatively long, slender, finger-like; apical process.

Last ventral segment of female about three-fifths as long as greatest width, latero-posterior margin roughly circular with a small median notch.

Types: Lectotype ♂, Buffalo, N. Y., June, 1887, E. P. Van Duzee. Lectoallotype, same data, here designated. Both types on hand for study and located in Iowa State College Museum, Ames, Iowa.

Additional Material Studied: This species is one of the most common of the genus and occurs throughout the United States from Utah eastward and possibly into Mexico, as specimens are on hand from Brownsville, Texas. Hundreds of specimens are on hand from all parts of this area.

Host Plants: Many host plants are recorded for this species. Specimens were examined collected from hemp in Missouri and *Heterotheca subaxillaris* in Texas. Ball (1932) writes "—was taken in numbers on pure stands of wild blackberry, (*Rubus* sp.) in New Jersey, the District of Columbia and again at Gainesville, Florida." Osborn (1915) writes "ordinarily occurs in grass-land and is very frequently taken in adult form from oak trees." Fletcher (1930) gives native grassland as the host plant in Texas. Gibson and Cogan (1915) give clover, alfalfa, grasses and woody shrubs as the hosts in Missouri. Van Duzee (1894) gives oak bushes as the host plant at Buffalo, N. Y.

Comparative Notes: This species is the only blackish species with a short crown and yellow clypeus. Specimens from southern Texas and Florida are smaller than those collected farther north, but are identical in other respects.

35. *Scaphytopius (Cloanthanus) cinnamoneus* (Osborn)

Platymetopius magdalensis var. *cinnamoneus*, Osborn, Herbert, Bull. Maine Agri. Exp. Sta., No. 288, p. 114, 1915.

Resembles *magdalensis* but with indistinct markings on crown, lighter face and with more slender paraphyses. Length: female 5 mm., male 4.5 mm.

Color: Crown fulvous mottled with light, with white markings as follows: thin line along anterior margin; wedge; and two spots along posterior margin, one next each eye and one on each side of median suture. Pronotum fulvous, irregularly marked with brown, pale vittae usually faintly evident. Scutellum fulvous to light brown with typical light markings. Face bright fulvous, slightly clouded along lateral margins, sharksmouth and vitta behind eye faintly indicated. Forewing semihyaline light fulvous, with numerous

brown irrorations, becoming fuscous on apex and outer anteapical cell; veins brown, darker on costa.

Structural Characteristics: Crown almost one and one-half times as long as width between eyes, anterior margin only slightly convex on each side of bluntly pointed apex; wedge over one-third length of crown. Pronotum about three-fourths as long as crown, two and one-fourth times as wide as length at middle and three and one-half times as wide as length behind eyes. Clypeus about twice as long as width at ocelli, somewhat constricted at antennae, slight concavity along sharksmouth. Clypellus relatively stout and enlarged near apex. Face in lateral view almost straight. Forewing with vein-like marks in brachial cell and about nine recurved veins to costa.

Genitalia: Valve about one and one-third as wide as length at middle, posterior margin bell-shaped to small, teat-like, rounded process at apex. Paraphysis with large basal, bulb-like process, almost parallel-margined to sharp apex. Aedeagus "L"-shaped, narrowest near slightly enlarged apex. Styles about four times as long as basal width, slightly sinuate near basal third, lobe on outer margin before stout, finger-like process on apical two-fifths.

Last ventral segment of female slightly less than twice as wide as length at middle, lateral margins slightly convex; posterior margin almost straight with small median notch.

Types: Lectotype ♂, Aug. 30, 1913, lectoallotype ♀, Aug. 5, 1913, Orono, Maine, Herbert Osborn, here designated, in the Snow Entomological Collections, were on hand for study.

Additional Material Studied: (Manitoba) Red Deer River, Mafeking, Birch River and Swan River. (Michigan) Thompson, Cheboygan Co., Bryants Bog and Mud Lake. (Minnesota) Eveleth and Itasca Park. (Wisconsin) Brule.

Host Plants: A long series was collected on *Chamaedaphne* at Itasca Park, Minnesota, by R. H. Beamer, and a pair was taken from the same host at Bryants Bog, Michigan, by H. B. Hungerford. "Bear berry" was given as the host of a long series collected at Mafeking, Manitoba, by R. H. Beamer. Both of these plants are in the heath family, so it is possible that the species is restricted to the family or certain plants in the family.

Comparative Notes: Although described as a variety of *magdalenensis*, the genitalia show this species to be more closely allied to *frontalis* than to any other. Several male specimens collected at

Toronto, Canada, in September are much darker and may represent the fall brood of this species.

36. *Scaphytopius (Cloanthanus) deltensis* Hepner

Scaphytopius (Cloanthanus) deltensis, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 97, 1936.

Resembling *fuscifrons*, but with pointed plates in male and last ventral segment of female produced at middle. Length: female 4.8 mm., male 4.4 mm.

Color: Crown irregularly mottled fuscous and ivory, lightest along anterior margin. Pronotum about same color as crown, vittae evident only on lateral margins. Scutellum dark brown, with typical white markings and usually a large orange area near each basal corner. Face fuscous and light mottled; vitta behind eye, shorter ones near ocelli and antennae and long sharksmouth, light. Forewings semihyaline white, fuscous vermiculations throughout, darkest on apical cells, darkest in males; veins fuscous, becoming black on costa.

Structural Characteristics: Crown only slightly longer at middle than next eyes; about as long as width between eyes, anterior margin convex on each side of a very bluntly pointed apex; wedge about one-third length of crown. Pronotum somewhat longer than crown, about two and one-fourth times as wide as length at middle and three and one-half times length behind eyes. Clypeus somewhat less than twice as long as width at ocelli, only slightly constricted at antennae. Clypellus relatively stout, slightly enlarged near apex. Face in lateral view strongly convex. Forewing with several vein-like marks in brachial cell, about twelve recurved veins to costa and sometimes extra cross-veins in clavus.

Genitalia: Valve somewhat shorter than greatest width, posterior margin almost straight on each side of a rounded apex; anterior margin with broad, short median lobe. Paraphysis bulbed at base, slender and completely spiraled on middle, enlarged before sharp apex. Aedeagus curved near base, gradually narrowing to blunt apex, with small teeth on dorsal margin. Styles about three times as long as width at base, somewhat sinuate near middle, distinct lobe on outer margin just before finger-like, apical process.

Last ventral segment of female about as long as greatest width, lateral margins straight and converging; posterior margin convex except for small median notch.

Types: Holotype ♂, allotype ♀, 7 ♀ and 1 ♂ paratypes, Delta, California, June 28, 1935, P. W. Oman, in the National Museum, Washington, D. C. Additional paratypes as follows: 1 ♀, Mt. Shasta, June 29, 1935, P. W. Oman; 8 ♀ ♀, Delta, June 28, 1935, R. H. Beamer.

Host Plants: The host plant is not known.

Comparative Notes: This species superficially resembles *fusci-frons*, but can be separated easily by the external genitalia.

37. *Scaphytopius (Cloanthanus) dorsalis* (Ball)

Platymetopius frontalis var. *dorsalis*, Ball, E. D., Ent. News, XX: p. 164, 1909.

Platymetopius bicolor, DeLong, D. M., Ohio Jour. Sci., XVII: p. 88, 1916.

Resembling *frontalis* but with crown light and without markings and without white aeroles in forewing. Length: female 4.8 mm., male 4.5 mm.

Color: Crown ivory to yellow without markings. Pronotum dark brown, fading to yellowish along anterior and lateral margins; vittae very faintly indicated in male, mottled ivory with large, dark brown spot near each basal corner in female. Face fulvous, slightly darker behind eyes. Forewing opaque dark chocolate brown with yellow apex in male, veins light brown; apex of clavus and apex of corium semihyaline, darkest on outer anteapical cell in female.

Structural Characteristics: Crown about one and one-third as long as width between eyes, anterior margin slightly convex on each side of pointed apex. Pronotum almost as long as crown, about two and one-half times as wide as length at middle and about four times length behind eyes. Clypeus about twice as long as width at ocelli, slight concavity inside each eye, only slightly constricted, if at all, at antennae. Clypellus relatively long, evenly and slightly enlarged from near base to near apex. Face in lateral view almost straight. Forewing with typical venation, several vein-like marks in brachial cell and six or seven recurved veins to costa.

Genitalia: Valve almost as long as basal width, posterior margin concave on each side of a bluntly pointed apex; anterior margin with median lobe. Paraphysis with basal bulb, slender to outer third, with distinct lateral process before enlarged, sharply pointed apex. Aedeagus curved near middle, broadest on basal half. Styles slightly over three times as long as basal width, sinuate near middle, small lobe on outer margin before long finger-like apical process.

Last ventral segment of female about five-eighths as long as

greatest width, latero-posterior margin broadly angled near middle on each side of a small median notch at apex.

Types: This species was described from two female types from Onaga, Kansas. Lectotype female, Onaga, Kansas, June 27, here designated, in the National Museum, Washington, D. C. Allotype male, Saratoga, Union Co., July 17, 1877, Uhler, here designated, in the Snow Entomological Collections. The holotype of *bicolor* was on hand for study, as well as the designated allotype of *dorsalis*.

Additional Material Studied: 1 ♀ with no collection data.

Host Plants: The host plant is not known.

Comparative Notes: This species is probably more closely related to *scriptus* than to any other species, but appears to be distinct. It evidently is quite rare, as the two female types, the pair studied, and the male type of *bicolor* are the only ones recorded.

38. *Scaphytopius (Cloanthanus) nigrifrons* (DeLong)

Platymetopius nigrifrons, DeLong, D. M., Conn. State Geological and Nat'l. Hist. Surv. Bull. 34, p. 103, 1923.

Resembling *frontalis*, but darker, with dark clypeus and with genital paraphyses enlarged near apex. Length: female 4.6 mm., male 4 mm.

Color: Crown black in male, fuscous in female, with light markings as follows: thin line along anterior margin; wedge and long, irregular, oblique mark on each side (in female these oblique marks may be broken into two more or less circular areas); two pairs of dots on posterior margin, one next each eye and one on each side of median suture (in the female, there is usually two dots on each side of median suture). Pronotum black with fulvous irrorations, male darkest; vittae evident. Scutellum fuscous to black with light markings at least indicated, female lighter. Face fuscous to black with light dots, and light markings as follows: vitta along posterior margin between eyes, long sharksmouth, faint vitta behind eye and shorter ones in front of eye near ocelli and antennae; face darkest on margins of genae and apex of clypellus. Forewings opaque black and fulvous, darkest in male, a few white aeroles on apical third.

Structural Characteristics: Crown about one and one-third as long as width between eyes, anterior margin convex on each side of bluntly pointed apex; wedge about one-third length of crown. Pronotum about as long as crown, two and one-half times as wide as

length at middle and about four times as wide as length behind eyes. Clypeus about twice as long as width at ocelli, definitely constricted at antennae. Clypellus stout, enlarged near apex. Face in lateral view convex. Forewing with irregular marks in brachial cell, seven or eight recurved veins to costa and often extra veins in clavus.

Genitalia: Valve about three-fourths as long as wide; posterior margin bell-shaped with a teat-like apical process; anterior margin with broad median lobe. Paraphyses enlarged on apical two-fifths with a sharp, lateral lobe near beginning of enlargement. Aedeagus in lateral view curved, narrowest near apex, and with small spines along dorsal margin. Styles about four times as long as basal width, sinuate near middle, lobe on outer margin before finger-like process on apical fourth.

Last ventral segment of female about one and one-half times as wide as length at middle, latero-posterior margin rounded.

Types: Holotype ♂, North Branford, Conn., July 12, 1921, B. H. Walden, in the DeLong Collection, Ohio State University, Columbus, Ohio.

Additional Material Studied: (Connecticut) New Haven. (Maryland) Plummers Island. (Ohio) Hocking Co.

Comparative Notes: This black species, without light aerole in wing, is quite distinctive, darker than *frontalis*, and with a black face; somewhat like *scriptus*, but darker.

39. *Scaphytopius (Cloanthanus) amplinotus* Hepner

Scaphytopius (Cloanthanus) amplinotus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 98, 1946.

Resembles *verecundus*, but larger, with large white spots throughout, and with lateral projection near apex of genital paraphysis. Length: female 4.6 mm., male 4 mm.

Color: Crown orange-fulvous with white markings as follows: thin line on anterior margin; wedge and oblique line on each side; three pairs of spots across crown before eyes, the median pair about size of wedge; on posterior margin a large spot at middle and a smaller spot next each eye. Pronotum same color as crown with irregular white vittae distinct and sometimes quite broad. Scutellum same color as crown, with typical markings and irregular markings, especially on disc, white. Genae and clypeus fulvous to yellow; area next lorae, vitta behind eye and shorter ones near antennae and ocelli, white. Forewing semihyaline orange-fulvous with large white areas throughout; veins dark on apical half and on costa.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin almost straight to pointed apex. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and three and one-half times length behind eye. Clypeus over twice as long as width at ocelli, slender, only slightly constricted, if at all, at antennae. Clypellus slender and slightly enlarged near apex. Forewing usually with claval veins nearest each other at cross vein, several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin convex on each side of pointed apex; anterior margin broadly rounded. Paraphyses slender on basal four-fifths, enlarged, with a short lateral process just before sharply pointed apices. Shaft of aedeagus in ventral view almost parallel-margined, in lateral view, long, slender, slightly curved and without processes. Styles slightly over three times as long as basal width, sinuate just beyond basal third, slightly enlarged on outer margin just before finger-like, apical process.

Last ventral segment of female with latero-posterior margin broadly rounded and with a short, broad median lobe.

Types: Holotype ♂, allotype ♀, and 3 ♀ and 26 ♂ paratypes, Hudson, Florida, July 13, 1939, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (Florida) 2 ♀ ♀, 1 ♂, Hudson, July 13, 1939, P. B. Lawson; 13 ♀ ♀, 19 ♂ ♂, Hudson, July 13, 1939, P. W. Oman; 2 ♀ ♀, Likely, July 24, 1934, R. H. Beamer; 1 ♀, 2 ♂ ♂, Lacoochee, Aug. 18, 1930, R. H. Beamer; 1 ♂, Eustis, Oct. 12, 1932, J. O. Pepper; 1 ♂, Old Town, July 11, 1939, P. B. Lawson and 1 ♂, Sanford, July 12, 1928, E. D. Ball. (Georgia) 1 pair, Okefenokee Swamp, July 25, 1939, 7 ♀ ♀, 1 ♂, July 27, 1939, and 2 ♀ ♀, 6 ♂ ♂, Aug. 3, 1934, R. H. Beamer.

Host Plants: The host plant is not known.

Comparative Notes: This species is the only one in this country with large white, unmarginated spots covering the entire dorsum.

40. *Scaphytopius (Cloanthanus) osborni* (Van Duzee)

Platymatopius osborni, Van Duzee, E. P., Ann. Ent. Soc. Amer., VII: p. 229, 1910.

Resembles *fuscifrons* but without blunt plates of male and with a different pattern on crown. Length: female 4.5 mm., male 4.3 mm.

Color: Crown brown with light markings as follows: short wedge; two large dots on each side between wedge and eye, sometimes united, a pair of short dashes behind wedge and two pairs of dots along posterior margin, one next each eye and one on each side of median suture. Pronotum gray and fulvous with brown to fuscous irrorations; vittae evident. Scutellum fulvous with typical light markings. Face ivory with brown to fuscous coarse irrorations, large irregular white blotches in lorae and clypellus and on adjoining area of genae; vitta behind eye and shorter ones near ocelli and antenna, distinct. Forewings semihyaline fulvous with dark irrorations and large milky aeroles throughout.

Structural Characteristics: Crown only slightly longer than width between eyes, only slightly longer at center than next eyes; apex rounded; wedge about one-fourth length of crown. Pronotum slightly longer than crown, about two and one-half times as wide as length at middle and four and one-half times length behind eyes. Clypeus about twice as long as width at ocelli, relatively broad, constricted at antennae. Clypellus considerably enlarged near apex. Face in lateral view definitely convex. Forewing with venation typical, several vein-like markings in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin roughly bell-shaped with a small, rounded tip; anterior margin with short, broad median lobe. Paraphyses slender on basal half, gradually broadened to a sharp point on outer third before sharply pointed apices. Aedeagus small, parallel-margined and semicircular. Styles more than three times as long as basal width, slightly sinuate near middle, small lobe on outer margin before finger-like process on apical fourth.

Last ventral segment of female about twice as wide as length at middle, latero-posterior margin with small lobe on each side of median lobe with small median notch.

Types: Holotype ♂, allotype ♀, Los Amates, Guatemala, Jan. 17, 1905, and Feb. 28, 1905, J. S. Hine, here designated, in the Osborn Collection, Ohio State University, Columbus, Ohio.

Material Studied: (Texas) 1 ♂, Marfa, Aug. 7, 1936, E. D. Ball. (Mexico) Tamazunchale and Jacala.

Host Plants: The host plant is not known.

Comparative Notes: The one male from Marfa, Texas, is the only record of this species collected in the United States. Since it

was collected during the same month that Dr. Ball collected in Mexico, it is possible that the specimen was mislabeled, in which case it does not occur in this country.

41. *Scaphytopius (Cloanthanus) andromus* (Ball)

Nasutoideus andomus, Ball, E. D., Can. Ent., LXIII, p. 221, 1931.

Resembling *magdalensis*, but smaller, and with process on parapsysis near apex. Length: female 4 mm., male 3.6 mm.

Color: Crown fulvous with white marks as follows: line along anterior margin; wedge and indistinct oblique line on each side; a pair of relatively large spots on disc before eyes and a pair of longer marks between these; on posterior margin, a spot at center and next each eye. Pronotum about same color as crown, dark irrorations, especially in male, light vittae usually evident, although often indistinct. Scutellum fulvous with typical light markings, usually some fuscous markings in male. Face fulvous, mottled with light, white markings as follows: long sharksmouth, vitta behind eye and shorter ones near ocellus and antennae. Apex of clypellus only slightly darkened, if at all. Face in lateral view slightly concave between anterior margin of eyes. Forewing semihyaline fulvous with small milky aeroles throughout.

Structural Characteristics: Crown a little more than one and one-half times as long as width between eyes, anterior margin slightly convex on each side of bluntly pointed apex; wedge over one-fourth length of crown. Pronotum about three-fourths as long as crown, about two and one-half times as wide as length at middle and four times length behind eyes. Clypeus about twice as long as width at ocelli, very slightly sinuate near antennae. Clypellus relatively slender, enlarged near apex. Forewing often with extra cross-veins in clavus, several vein-like marks in brachial cell and about nine recurved veins to costa.

Genitalia: Valve a little wider than length at middle, posterior margin convex on each side of very bluntly pointed apex; anterior margin with broad, rounded lobe on median half. Paraphyses longer than plates, coiled near base, small lateral process on outer third before enlargement near sharply pointed apices. Aedeagus in lateral view almost straight, small teeth on dorsal margin on apical half. Styles about three times as long as basal width, slightly sinuate near middle, lobe on outer margin before finger-like apical process.

Last ventral segment of female slightly less than twice as wide as length at middle, latero-posterior margin unevenly rounded.

Types: Holotype ♂, April 18, 1927, allotype ♀, July 7, 1926, Sanford, Florida, E. D. Ball, in the National Museum, Washington, D. C. One ♂ paratype, Sanford, Florida, July 7, 1926, E. D. Ball, on hand for study.

Additional Material Studied: (Florida) Ft. Mead, Branford, La Belle, Childs, Elfers, Sanford, Gainesville.

Host Plants: Ball (1932) writes, "Nymphs and adults were taken commonly in Florida on the fetter bushes (*Pieris* sp.)."

Comparative Notes: The male of this species somewhat resembles *scriptus*, but the female is very light and quite distinctively colored.

42. *Scaphytopius (Cloanthanus) verecundus* (Van Duzee)

Platymetopius verecundus, Van Duzee, Ann. Ent. Soc. Amer., III, p. 227, 1910.

Resembling *magdalensis*, but smaller, with a longer crown and without lateral process on parapsysis. Length: female 4.2 mm., male 4 mm.

Color: Crown mottled brown with sometimes a reddish tinge and white markings as follows: incomplete narrow line along anterior margin, wedge and oblique line on each side; two large irregular marks sometimes fused between each eye and wedge, and a slender line about size of wedge on each side of median suture; on posterior margin, a large spot at middle and a smaller one next each eye. Pronotum usually somewhat lighter than crown, fuscous markings thickest near posterior margin, light vittae usually evident, especially on sides. Scutellum orange with typical light markings. Clypeus mottled brown and fulvous with irregular light line along posterior margin; relatively long sharkmouth. Lorae and clypellus mottled brown, with apex of clypellus black. Genae mottled, darkest along lateral margins; irregular area next lorae, vitta behind eye and shorter ones near ocellus and antenna, white. Forewing semihyaline fulvous with irregular milky aeroles throughout; veins darkest at apex and on costa; outer anteapical cell usually darkest.

Structural Characteristics: Crown over twice as long as width between eyes, anterior margin almost straight on each side of relatively sharp crown, especially in female; wedge slightly less than one-fourth length of crown. Pronotum less than two-thirds as long as crown, about two and one-half times as wide as length at middle and three and one-half times length behind eyes. Clypeus almost two and one-half times as long as width at ocelli; only slightly sinuate near antennae, slight depression at end of sharkmouth.

Clypellus broadest near apex. Face in lateral view concave between anterior margin of eyes. Forewing with claval veins approaching each other at cross-vein, several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin oval; anterior margin with lobe on median half. Paraphyses about two and one-half times as long as styles, slender, enlarged on outer fourth before sharp apices. Aedeagus in lateral view almost straight and parallel-margined, small teeth on dorsal margin. Styles about three times as long as greatest width, sinuate just before middle, lobed on outer margin before a finger-like process on apical third.

Last ventral segment of female slightly less than twice as wide as length at middle, latero-posterior margin rounded to a broad, short, median lobe.

Types: Lectotype ♀, Fort Myers, Florida, May 3-5, 1908, Van Duzee, in the National Museum, Washington, D. C., here designated. This was the only cotype located.

Material Studied: (Florida) Sanford, Hobe Sound, New Port Richey, Hilliard, Wakulla, Branford, Yankeetown, Hibernaria, Alachua Co., Lacoochee and Old Town. (Georgia) Adel, Folkston and Okefenokee Swamp. (Mississippi) Ireland. (South Carolina) Plantersville, Conway and New Bern. (North Carolina) Shallotte, Wilmington and Rocky Point.

Host Plants: Ball (1932) writes "—taken abundantly at Sanford, Florida, on mixed stands of low shrubs of the families *Ericaceae* and *Vacciniaceae* growing in flat woods."

Comparative Notes: The sharp crown and reddish color readily separate this species from any other.

43. *Scaphytopius (Cloanthanus) insolitus* Hepner

Scaphytopius (Cloanthanus) insolitus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 99, 1946.

Resembling *verecundus* somewhat, but smaller, with shorter crown and lobed genital paraphyses. Length: female 3.4 mm., male 3 mm.

Color: Crown mottled reddish, with light markings as follows: thin wedge, three pairs of long marks in band before eye, the median pair often united with a pair of spots near median suture on posterior margin. Pronotum, scutellum and face more or less mottled reddish-fulvous, sharksmouth indicated. Forewing translucent dark fulvous, becoming fuscous on coastal and apical margins.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, anterior margin almost straight on each side of pointed apex. Pronotum about four-fifths as long as crown, two and one-third times as wide as length at middle and four and one-half times length behind eyes. Clypeus twice as long as width at ocelli, somewhat sinuate at antennae. Clypellus broad and only slightly enlarged at apex. Face somewhat convex in lateral view. Forewing with typical venation, vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve somewhat wider than length at middle, posterior margin bell-shaped, anterior margin with large lobe on median half. Aedeagus in lateral view straight, converging toward blunt apex, toothed along dorsal margin. Paraphyses slender on basal two-thirds, somewhat enlarged toward apices with small, pointed lateral lobes. Styles about two and one-half times as long as basal width, somewhat sinuate on basal fourth, slightly lobed on outer margin before finger-like process on apical third.

Last ventral segment of female about three-fifths as long as greatest width, latero-posterior margin rounded.

Types: Holotype ♂, allotype ♀, Sanford, Fla., June 17, 1927, E. D. Ball, in the National Museum, Washington, D. C.

Host Plants: The host plant is not known.

Comparative Notes: This small species, reddish and distinctively marked, is undoubtedly rare, as only the one pair is known.

44. *Scaphytopius (Cloanthanus) magdalensis* (Provancher)

Platymetopius magdalensis, Provancher, L., *Petite Faune Entomologique du Canada* (VIII, Hemiptera) III, p. 276, 1889.

Platymetopius obscurus, Osborn, *Ohio Nat.*, V: p. 274, 1905.

Platymetopius carolinus, Lathrop, *Ohio Jour. Sci.*, XVII: p. 128, 1917.

Cloanthanus atratus, DeLong, D. M., *Ohio Jour. Sci.*, VL: p. 27, 1945.

Cloanthanus vaccinum, DeLong, D. M., *Ohio Jour. Sci.*, VL: p. 27, 1945.

Resembling *acutus*, but with shorter crown, with different color pattern, a uniformly colored face and with a sharp process on genital paraphysis near middle. Length: female 4.8 mm., male 4.5 mm.

Color: Crown mottled fulvous-brown with light markings as follows: wedge, irregular markings from eye along anterior margin; two or three pairs of spots, sometimes fused, forming a very irregular band across crown before eyes; two pairs of spots on posterior margin, one pair next median suture, the other next eyes. Pronotum fulvous-brown, more or less irrorate with dark, light

vittae usually very faintly indicated. Scutellum fulvous with typical white markings. Clypeus brown and light mottled, darkest in area of long sharksmouth. Lorae and clypellus as in clypeus, but with a large light spot on each loral sclerite and apex of clypellus infuscated. Genae same color as clypeus, darkest on disc, white vitta behind eye and shorter ones near ocellus and antenna, distinct. Forewing semihyaline yellow with numerous milky aeroles; veins brown, becoming fuscous at apex and on costa, darker in males.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, anterior margin slightly convex on each side of bluntly pointed apex; wedge about one-fourth length of crown. Pronotum almost as long as crown in male, shorter in female, about two and one-half times as wide as length at middle and a little less than four times length behind eyes. Clypeus twice as long as width at ocelli, slightly sinuate at antennae. Clypellus slightly enlarged at apex. Forewing with typical venation, numerous vein-like marks in brachial cell and nine or ten recurved veins to costa.

Genitalia: Valve about three-fourths as long as greatest width, roughly triangular, posterior margin somewhat convex on each side of bluntly pointed apex; anterior margin with broad, short lobe. Paraphyses long, slender on basal half, small, sharp process near middle, enlarged beyond to sharp apices. Aedeagus in lateral view rounded near base, almost parallel-margined on basal half, slightly narrowed to blunt apex; small tooth-like processes on dorsal margin near apex. Styles about twice as long as basal width, greatly sinuate near middle, large lobe on outer margin before finger-like apical process.

Last ventral segment of female slightly over twice as long as greatest width, latero-posterior margin roughly circular.

Types: The type of *magdalensis* should be in the Provincial Museum, Quebec, Canada. The type of *obscurus* is in the Osborn Collection, Ohio State University, Columbus, Ohio. The type of *carolinus* was destroyed in the Clemson College fire some years ago. Types of *atratus* and *vaccinium* in Illinois Natural History Survey collection, Urbana, Ill. Paratypes of *obscurus*, *atratus* and *vaccinium* were on hand for study.

Additional Material Studied: Specimens are on hand from many points from Florida to Maine west of the Rocky Mountains, as well as from eastern Canada.

Host Plants: Ball (1932) writes "Dr. Osborn credits this to blueberries. Dr. Irene Debrosky tells me that she has carried this species through from egg to adult on the cranberry. The writer has taken this dark-faced species while sweeping shrubs in low damp places in northern Wisconsin and again at Woods Hole, Massachusetts, both situations where cranberries are abundant." Horsfall (1916) writes of the species in Missouri "From blackjack brush in July." Lowry (1933) regarding this species in New Hampshire writes "rare on *Vaccinium pennsylvanicum*."

Comparative Notes: As might be expected from its wide range, this species varies considerably. Specimens from Florida are much smaller, but the small process near middle of parapsysis readily separates this species from any other, with the exception of *nigri-frons*, which is much darker.

45. *Scaphytopius (Cloanthanus) scriptus* (Ball)

Platymetopus scriptus, Ball, E. D., Ent. News, XX: p. 165, 1909.

Cloanthanus varius, DeLong, D. M., Ohio Jour. Sci., VL: p. 26, 1946.

Color: Crown brown to fuscous in male, fulvous in female, with light markings as follows: narrow line along anterior margin; wedge and short oblique line on each side; two irregular marks on each side, often coalesced, half-way between eye and wedge, and a smaller, longer mark, often indistinct, extending on each side of median suture from near wedge to base of crown; two pairs of spots on posterior margin, one pair near median suture and another next eyes. Pronotum same color as crown, light vittae irregular, but present. Scutellum same color as crown with typical light markings. Face about same color as crown with light markings as follows: relatively long sharksmouth, vitta behind eye and shorter ones at ocelli and antennae. Forewing semihyaline fulvous with cells in corium of male almost entirely fuscous except next veins, fuscous area in female restricted to outer anteapical cell and adjoining area of costa; light aeroles throughout, but especially near apex.

Structural Characteristics: Crown about one and one-third as long as width at ocelli, anterior margin slightly convex on each side of bluntly pointed apex; wedge about one-fourth length of crown. Pronotum slightly shorter than crown, about two and one-half times as wide as length at middle and four and one-half times length behind eyes. Clypeus over twice as long as width at ocelli, evenly narrowed beyond antennae in male, slightly sinuate in female; slight concavity at end of sharksmouth. Clypellus relatively stout, broad-

ened near apex. Face in lateral view somewhat concave between anterior margin of eyes. Forewing with typical venation, several vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin slightly convex on each side of bluntly pointed apex; anterior margin with broad, rounded lobe on median half. Paraphyses extending beyond plates, almost parallel-margined to small lateral process on outer fourth before sharp apices. Aedeagus in lateral view almost as long as style, tooth-like marks on dorsal surface, apex flattened. Styles about three times as long as basal width, inner margin abruptly enlarged near middle, outer margin with distinct lobe on middle before finger-like apical process.

Last ventral segment of female one and two-thirds as wide as length at middle, latero-posterior margin evenly rounded to small median lobe.

Types: Lectotype ♂, Onaga, Kansas, May 27, 1902, here designated, in the National Museum, Washington, D. C. It is presumed that the collector was Crevecoeur. Allotype ♀ and one ♀ paratype, Douglas Co., Kansas, Aug., 1923, W. Robinson, here designated, in the Snow Entomological Collections. Additional paratype ♀ ♀ as follows: (Kansas) 1, Leavenworth Co., July 1, 1924, R. H. Beamer; 3, Douglas Co., June 6, 1918, C. P. Alexander and 1, Douglas Co., Aug. 28, 1928, P. B. Lawson. (Indiana) 1, Gary, June 24, 1934, M. W. Sanderson. (Tennessee) 1, Clarksville, July 4, 1917, D. M. DeLong and 2, Clarksville, June 26, 1914. (Maryland) 1, Annapolis, Sept. 27, 1931, 1, June 2, 1932, P. W. Oman; 1, Plummers Island, Sept. 2, 1913, R. C. Shannon and 1, Aug. 4, 1907, W. L. McAtee. (Virginia) 1, Dismal Swamp, Aug. 13, 1934, R. H. Beamer; 1, Chincoteague Island, Sept. 22, 1938, J. C. Bridwell; 1, Nelson Co., June 19, 1925, W. Robinson and 1, L. Drummond, Sept. 10, 1933, P. W. Oman. (Mississippi) 1, Shuqulak, July 16, 1930, R. H. Beamer.

Host Plants: The host plant is not known.

Comparative Notes: This species is found over most of the eastern half of the United States, except the extreme south, and is distinguished by its short crown with small markings and heavily marked forewings.

46. *Scaphytopius (Cloanthanus) scriptus meridianus* Hepner

Scaphytopius (Cloanthanus) scriptus subsp. *meridianus*, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 100, 1946.

Resembles *scriptus*, but lighter color, longer crown and more southern in distribution. Length: female 4.7 mm., male 3.8 mm.

Color: Crown mottled brownish, with light markings as follows: wedge; circular area on apical half, broken by three lines behind wedge; irregular area along posterior margin. Pronotum pale fulvous, irregularly marked with brown, vittae only lightly indicated. Scutellum fulvous with typical markings indicated. Face fulvous, mottled with brown, light sharksmouth and vitta behind eye, evident. Forewing semihyaline fulvous, veins and irrorations fuscous in male, fulvous in female.

Structural Characteristics: Crown slightly less than twice as long as width between eyes, anterior margin straight to slightly convex on each side of pointed apex. Pronotum about three-fourths as long as crown, about two and one-third times as wide as length at middle and three and one-half times length behind eyes. Clypeus slightly over twice as long as width at ocelli, slightly, if any, sinuate at antennae. Clypellus broad, enlarged and rounded at apex. Face in lateral view straight in male, slightly concave between anterior margin of eyes in female. Typical venation, vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin bell-shaped; anterior margin with broad, short lobe on median third. Shaft of aedeagus in lateral view slightly curved, almost parallel-margined to blunt apex, rugulose area on dorsal margin near apex. Paraphysis slender on basal two-thirds, coiled near middle, slender lateral process before enlarged, sharply pointed, apical portion. Styles about three times as long as basal width, slightly sinuate near middle, distinct lobe on outer margin before bluntly pointed, finger-like apical process.

Last ventral segment of female slightly more than half as long as greatest width, latero-posterior margin rounded.

Types: Holotype ♂, allotype ♀, 2 ♂♂, and 1 ♀ paratypes, Branford, Florida, July 31, 1930, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (Florida) 1 ♂, Branford, Aug. 4, 1939, R. H. Beamer; 1 ♀, Branford, July 16, 1934, R. H. Beamer; 1 ♀, Ft. Mead, Aug. 13, 1930, L. D. Tuthill; 4 ♀♀, 1 ♂, Ft. Mead, Aug. 13, 1930, R. H. Beamer;

2 ♀ ♀, Ft. Mead, Aug. 13, 1930, P. W. Oman; 3 ♀ ♀, 2 ♂ ♂, Hilliard, July 28, 1934, M. E. Griffith; 1 pair, Hilliard, Aug. 31, 1930, L. D. Tuthill; 1 pair Hilliard, Aug. 9, 1930, John Nottingham; 1 ♂, Hilliard, July 28, 1934, 1 ♀, Aug. 31, 1930, R. H. Beamer; 2 ♂ ♂, Hilliard, Aug. 19, 1930, P. W. Oman; 1 ♂, Waldo, Aug. 18, 1930, R. H. Beamer; 1 ♀, Wildwood, Aug. 2, 1930, John Nottingham; 5 ♀ ♀, 3 ♂ ♂, Suwanee Spgs., Aug. 2-3, 1939, R. H. Beamer and 1 ♂, Pensacola, July 12, 1934, R. H. Beamer. (Georgia) 2 ♀ ♀, Okefenokee Swamp, July 27, 1939, and 1 ♀, Aug. 3, 1934, R. H. Beamer. (Louisiana) 1 ♂, "La. Carl F. Baker."

Additional specimens, somewhat larger, are on hand from Mississippi and Arkansas.

Host Plants: The host plant is not known.

Comparative Notes: This species might be confused with *verecundus* in Florida but lacks the red color, has a shorter crown and is easily separated by the male genitalia.

47. *Scaphytopius (Cloanthanus) angustatus* (Osborn)

Platymetopius angustatus, Osborn, Rept. of New York State Entomologist (30th Report), p. 518, 1905.

Resembles *acutus*, but pale greenish-fulvous in color, different color pattern on crown and face not greatly darkened on lateral margin. Length: female 5 mm., male 4 mm.

Color: Crown pale greenish-fulvous with indistinct darker markings, especially next eyes and near wedge. Pronotum gray to fulvous with brown irrorations, often lightest on anterior and lateral margins. Scutellum same color or slightly darker than pronotum, typical light markings usually at least indicated. Face about same color as crown, sharksmouth indicated and a few dark irrorations near basal margin. Forewing semihyaline fulvous, often with a faint greenish tinge, light aeroles in anteapical and apical cells and along costa; veins concolorous except at apex and along costa.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, almost straight margined on each side of blunt apex; wedge about one-third length of crown. Pronotum slightly over twice as wide as length at middle and about four times length behind eyes. Clypeus almost straight margined. Clypellus relatively slender, widest near apex. Face in lateral view almost straight. Forewings with venation usually obscured, five or six recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin with sides only slightly convex to a sharp apex; anterior margin only slightly concave to a short, broad median process. Paraphyses slender, about twice as long as styles, somewhat coiled on basal half, narrowest on outer third, only slightly enlarged before sharp apices. Aedeagus simple, curved near middle, slightly produced on dorsal margin. Styles almost three times as long as basal width, constricted on basal third, outer margin lobed on apical third to finger-like apical process.

Last ventral segment of female about one and one-half times as wide as length at middle, latero-posterior margin rounded to a small lobe on each side of median notch.

Types: Lectotype ♀, lectoallotype ♂, Cold Spr. Harbor, New York, Aug. 18, 1904, H. Osborn, here designated, in the Osborn Collection, Ohio State University, Columbus, Ohio. The original description gives Oyster Bay as the collection locality, but Prof. Osborn has said that these two localities are the same, as Cold Spring Harbor is within Oyster Bay. One specimen on hand from the type series.

Additional Material Examined: (Minnesota) Itasca Park and Bena. (Wisconsin) Florence and Brule. (Maine) Fryeburg.

Host Plants: Ball (1932) writes "—has taken this species from Jack pine in several places in northern Wisconsin and has examined specimens from New Hampshire, (Lowry) taken from pitch pine." Lowry (1933) writes regarding the species in New Hampshire "common on pitch and red pine."

Comparative Notes: This greenish species has the crown pattern faint and variable. The color is quite distinctive and so far as known, is the only species in the genus found on pine.

48. *Scaphytopius (Cloanthanus) calliandrus* (Ball)

Nasutoides calliandrus, Ball E. D., Can. Ent., LXIII: p. 222, 1931.

Resembling *loricatus*, but with lighter scutellum, much shorter crown and with genital paraphyses. Length: female 4 mm., male 3.8 mm.

Color: Crown mottled fuscous with light markings as follows: wedge; two pairs of marks along anterior margin, a small pair just in front of eyes and a larger oblique pair about half way from eye to wedge; a small dot on each side of posterior end of wedge; on posterior margin, a dot next each eye and one or two pairs of dots

between these. Pronotum same color as crown with light vittae indicated, especially on lateral margins. Scutellum ivory to orange, with a few black marks, especially along base and at apex. Face ivory to pale fulvous with irregular brown irrorations, often reduced; sharksmouth small; white vitta behind eye and shorter ones near ocelli and antennae. Forewing semihyaline white with heavy irrorations and areas throughout; veins dark.

Structural Characteristics: Crown about one and two-fifths times as long as width between eyes, anterior margin slightly convex on each side of blunt apex; wedge short. Pronotum about as long as crown, slightly less than two and one-half times as wide as length at middle, and four and one-half times length behind eyes. Clypeus relatively slender, about two and one-half times as long as width at ocelli, slightly sinuate near antennae. Clypellus relatively slender and enlarged near apex. Face in lateral view distinctly convex. Forewing with typical venation, several vein-like markings in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin straight on each side of truncate apex; anterior margin concave on each side of a slender, rounded lobe at middle. Paraphyses extending well beyond apex of plates, almost parallel-margined to sharp apices. Aedeagus in lateral view "V"-shaped, shaft more slender but about same length as basal part. Styles about three times as long as width at base, "dog-legged" near base, almost parallel-margined to small lobe on outer margin before small finger-like apical process.

Last ventral segment of female about twice as wide as length at middle, posterior margin with a lobe on outer margin and a smaller lobe at middle, with a slight median notch.

Types: Holotype ♀, Tucson, Ariz., June 22, 1930, allotype ♂, Tucson, Ariz., June 21, 1930, E. D. Ball, in the National Museum, Washington, D. C. Two paratypes on hand, ♂, Coolidge Dam, Ariz., May 18, 1930, E. D. Ball and ♀, Tucson, Ariz., Oct. 20, 1929, E. D. Ball.

Additional Material Studied: (California) Mountain Spgs., and Indio. (Arizona) Baboquivari Mts., Miami, Sabino Canyon, Gila Co., Mescal, Patagonia, Tubac, Hope, Nogales, Huachucua Mts., Castle Hot Spgs., Mustang Mts., Alamo, Ruby, Safford, Arivaca, Vail, Congress Jct., Santa Catalina Mts., Tombstone, Atascosa Mts., Quinlan Mts., La Osa River, Empire Mts., Naco and Hereford.

(Texas) San Ygnacio, Three Rivers, Catarina, Alpine, Marathon, Valentine, George West, Corrizo Spgs., Starr Co. and Presidio Co.

Host Plants: Ball (1932) writes "—has been found only on the low clumps of the fairy duster (*Calliandra eriophylla*) in Arizona."

Comparative Notes: This small, dark species is easily recognized by the yellowish to orange scutellum in sharp contrast to the much darker forewings.

49. *Scaphytopius (Cloanthanus) analis* var. *castranus* (Ball)

Convelinus analis var. *castranus*, Ball, E. D., Can. Ent., LXIII: p. 223, 1931.

Somewhat resembling *nigricollis*, but gray with dark dots, crown more pointed and with genital paraphyses. Length: female 4.1 mm., male 3.8 mm.

Color: Crown ivory with pale brown dots and irrorations; wedge and irregular area on each side without irrorations. Some specimens have only a few dots. Pronotum white with sparsely-spaced dark dots throughout. Scutellum ivory with an orange spot near each basal corner and a few dark dots, especially near apex. Face ivory with scattered dark dots, thickest behind eyes. Forewing semihyaline white with scattered dots, especially along veins; apex and costa darkest.

Structural Characteristics: Crown about one and one-third as long as width between eyes, anterior margin slightly convex on each side of bluntly pointed apex; wedge about one-third length of crown, sometimes indistinct. Pronotum almost as long as crown, two and one-half times as wide as length at middle, and four and one-half times length behind eyes. Clypeus about twice as long as width at ocelli, slightly constricted at antennae. Face in lateral view distinctly convex. Forewing with typical venation, several vein-like marks in brachial cell and about twelve recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin distinctly convex on each side of blunt apex; anterior margin slightly concave on each side of rounded median lobe. Paraphyses slender, almost parallel-margined to sharp apices. Aedeagus in lateral view "U"-shaped, shaft about as long, but more slender than base. Styles about three times as long as basal width, only slightly narrowed at middle, small lobe on outer margin before finger-like apical process.

Types: Holotype ♀, June 21, 1930, allotype ♂, May 10, 1930, both Tucson, Arizona, E. D. Ball, in the National Museum, Washington, D. C.

Material Studied: (Arizona) Tucson, Tempe and Hope.

Host Plants: Ball (1932) writes that this species is confined strictly to the desert iron wood (*Olneya testota*).

Comparative Notes: This species was originally placed in the genus *Convelinus*, but the genitalia are much different from *nigricollis*, showing more resemblance to *calliandrus*. This might be a synonym of *analis*, as that species was not examined by the author.

50. *Scaphytopius (Cloanthanus) radiatus* Hepner

Scaphytopius (Cloanthanus) radiatus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 101, 1946.

Resembling *loricatus*, but lighter, with a dark face, different markings on crown and with genital paraphysis. Length: female 4 mm., male 4 mm.

Color: Crown brown and white mottled, with the white markings giving the appearance of lines radiating toward the apex. Pronotum gray with fuscous markings; vittae evident, especially on sides. Scutellum dark orange to brown with typical light markings. Clypeus fulvous with brown irrorations excepting small sharksmouth. Clypellus and lorae same as clypeus. Genae same as clypeus, darkest behind eye, light vitta behind eye and shorter ones near ocellus and antenna, evident. Forewing semihyaline fulvous with white aeroles or areas; many brown vermiculations throughout especially in male, darkest at apex and on costa.

Structural Characteristics: Crown slightly less than one and one-half times as long as width between eyes; anterior margin slightly convex on each side of bluntly pointed apex; wedge about one-fifth length of crown. Pronotum somewhat shorter than crown, two and one-fourth times as wide as length at middle and about four times length behind eyes. Clypeus slightly more than twice as long as width at ocelli, only slightly sinuate, if at all, at antennae. Face in lateral view convex in male, concave between anterior margin of eyes in female. Forewing with typical venation; several vein-like marks in brachial cell and about nine recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin broadly convex on each side of small teat-like process at apex; anterior margin with small lobe on median half. Paraphyses long, slender and almost parallel-margined to sharp apices. Aedeagus in lateral view roughly "L"-shaped, shaft longer but narrower than basal portion. Styles about four times as long as basal width,

slender, with narrow, long lobe on outer margin before outwardly directed apical process.

Last ventral segment of female almost twice as wide as length at middle, lateral margins slightly convergent, posterior margin with small lobe at each side and a broader lobe on each side of small median notch.

Types: Holotype ♂, allotype ♀, and 2 ♂ and 6 ♀ paratypes, Three Rivers, Texas, June 27, 1938, R. H. Beamer, in the Snow Entomological Collections. One ♂ paratype, Sinton, Texas, Dec. 25, 1945, R. H. Beamer.

Host Plants: The host plant is not known.

Comparative Notes: The brown crown, with light lines radiating toward apex, easily separates this species from any other in southern Texas. The male collected in December is darker, with shorter lineations on crown, but the genitalia are almost identical to the type series. From the description of *flavens* DeLong, this species differs in the markings on the crown and with many more markings on the forewing.

51. *Scaphytopius (Cloanthanus) modicus* Hepner

Scaphytopius (Cloanthanus) modicus, Hepner, Jour. Kan. Ent. Soc., XIX: p. 102, 1946.

Resembling *magdalensis*, but smaller, lighter in color, a different pattern on crown and greatly produced last ventral segment of female. Length: female 3.6 mm., male 3.2 mm.

Color: Crown fulvous except for light markings as follows: short wedge; most of area before eyes; two pairs of spots along posterior margin, one next each eye and one on each side of median suture. Pronotum fulvous with anterior margin lightest; many brown irrorations in male, almost none in female; vittae evident. Scutellum fulvous to orange with typical light markings. Clypeus ivory to fulvous with dark dots, excepting small sharksmouth. Clypellus and lorae same as clypeus, but with fewer markings. Genae darker than clypeus, with vitta behind eye and shorter ones near ocelli and antennae, distinct. Forewing fulvous with few irrorations.

Structural Characteristics: Crown almost one and one-half times as long as width between eyes, slightly convex on each side of bluntly pointed apex; wedge very short. Pronotum almost as long as crown, about two and one-half times as wide as length at middle and four and one-half times length behind eyes. Clypeus slightly over twice as long as width at ocelli, very slightly sinuate at an-

tennae. Clypellus slightly enlarged near apex. Face in lateral view distinctly convex in male, almost straight in female. Forewing with typical venation, several vein-like marks in brachial cell and about nine recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin convex on each side of small median lobe; anterior margin with long, bluntly pointed lobe. Plates very slender, concave on inner margin. Paraphyses relatively stout, slightly longer than plates, broadest on outer fifth before sharply pointed apices. Aedeagus in lateral view short, curved and parallel-margined. Styles about twice as long as basal width, constricted near middle, lobed on outer margin before sharply pointed, outwardly projecting apical process.

Last ventral segment of female about two-thirds as long as greatest width, latero-posterior margin with very long, notched median lobe.

Types: Holotype ♂, allotype ♀, Cameron Co., Texas, Aug. 3, 1928, R. H. Beamer, in Snow Entomological Collections.

Host Plants: The host plant is not known.

Comparative Notes: This is one of the smallest species in southern Texas and the genitalia are quite distinctive—the slender plates, short styles and stout paraphyses of the male and the strongly produced last ventral segment of the female are unlike any other species in the area.

52. *Scaphytopius (Cloanthanus) pallidicapitatus* Hepner

Scaphytopius (Cloanthanus) pallidicapitatus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 108, 1946.

Resembling *castranus* but darker, more distinct pattern on crown and with shorter aedeagus. Length: female 4 mm., male 4 mm.

Color: Crown fulvous marked with brown; wedge, irregular band before eyes and posterior margin without markings. Pronotum gray with sparsely spaced dark dots, vittae visible on lateral margins. Scutellum yellow to fulvous, darkest near basal corners. Face yellow to fulvous with sparsely spaced dots throughout, especially on lateral margins of genae; sharksmouth small; apex of clypellus only slightly darkened. Forewings semihyaline white, darkened posteriorly; veins brown, darkest on posterior and costal margins.

Structural Characteristics: Crown slightly longer than width between eyes, anterior margin slightly convex on each side of blunt apex; wedge relatively small. Pronotum about as long as crown, almost two and one-half times as wide as length at middle and

about five times length behind eyes. Clypeus slightly over twice as long as width at ocelli, slightly sinuate near antennae. Clypellus definitely constricted near base and enlarged near apex. Face in lateral view convex. Forewings with vein-like markings in brachial cell, about eleven recurved veins to costa and sometimes extra veins in clavus.

Genitalia: Valve about as long as greatest width, posterior margin distinctly convex on each side of truncate lobe on median third. Plates slender. Paraphyses slender, extending slightly beyond apex of plates, apices pointed. Aedeagus in lateral view very short, slightly curved and parallel-margined. Styles about four times as long as basal width, almost parallel-margined to rounded outer margin before sharply pointed apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margins slightly convergent, posterior margin rounded to very small median notch.

Types: Holotype ♂, allotype ♀, and 3 ♂ and 2 ♀ paratypes, Mission, Texas, July 5, 1938, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes from Texas as follows: 2 ♀ ♀, Starr Co., July 30, 1928, 4 ♀ ♀, 2 ♂ ♂, July 5, 1938, R. H. Beamer; 1 ♀, Starr Co., July 30, 1928, L. D. Beamer; 1 pair, Hidalgo Co., July 30, 1928, R. H. Beamer and 3 pairs, 12 miles west of Mission, Dec. 26, 1945, R. H. Beamer.

Host Plants: The host plant is not known.

Comparative Notes: The very light crown, with speckled face, is distinctive. A specimen from Calcasieu Parish, La., is probably this species, but the abdomen is missing. This species is near *brevis* but the genitalia are different.

53. *Scaphytopius (Cloanthanus) nigriviridis* (Ball)

Platymetopus nigriviridis, Ball, E. D., Ent. News, XX: p. 163, 1909.

Resembles *trilineatus* in the female, but much smaller and lighter; the male has a much shorter crown, somewhat resembling *castranus*, but more slender and without dots on dorsum. Length: female 4.5 mm., male 3.8 mm.

Color: Crown greenish and with three or four black vittae on each side of median suture, restricted to apical two-thirds. Pronotum yellowish-green, usually darkest on disc, without markings except for sometimes an indication of vittae. Scutellum slightly lighter than pronotum and either without markings or, at most, with two or

three short brown lines along anterior margin. Face greenish-yellow, without markings except for a few brown vermiculations along base in area of sharksmouth and sometimes behind eye; sharksmouth short in the male, long in the female. Forewing semihyaline ivory on clavus, brachial, apical and anteapical cells, colorless on remainder of wing; sometimes clouded with brown or with five brown spots on inner half of clavus and apical half of corium; veins colorless except for two or three recurved veins to costa.

Structural Characteristics: Crown about one and one-half times as long as width between eyes in male, two and one-half times basal width in female; anterior margin convex on each side of broadly pointed apex in male, somewhat concave on each side in female; wedge short in male, half length of crown in female. Pronotum three-fourths as long as crown in male, one-half length of crown in female; two and one-fourth times as wide as length at middle and four times length behind eyes. Clypeus about twice as long as width at ocelli in male, two and two-thirds times width in female; only slightly sinuate at antennae, if at all. Clypellus slender, only slightly enlarged at apex. Face in lateral view convex in male, almost straight in female. Forewing with about five recurved veins on costa (with only two or three darkened) and sometimes extra cross-veins in clavus.

Genitalia: Valve wider than greatest length, posterior margin slightly concave near base, remainder evenly rounded; anterior margin concave on each side of relatively long median lobe. Paraphyses extending well beyond plates, enlarged, bulb-like near sharp apices. Aedeagus in lateral view broad and "U"-shaped. Styles short, less than three times as long as basal width, sinuate near middle, lobed on dorsal margin just before short, slender, outward-projecting apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margin slightly convex and converging; posterior margin with slight concavity at middle, small lobe on each side and another small lobe on each outer margin, giving a four-lobed appearance.

Types: Holotype ♀, allotype ♂, Tiajuana, Calif., June 15, 1908, in the National Museum, Washington, D. C., here designated.

Material Studied: (Nevada) Las Vegas. (California) Dulzura. (Arizona) Arivaca, Congress Jct., Hereford, Baboquivari Mts., Santa Rita Mts., Alamo, Yarnell, Tucson Mts., Tubac, Mescal,

Patagonia, Miami, Huachucua Mts., Pima Co., Hereford and Bradshaw Mts. (New Mexico) Eddy Co., and White City. (Texas) Davis Mts.

Host Plants: Ball (1932) writes "—taken by the writer in abundance, both nymphs and adults, on *Hymenoclea monogyra* in southern Utah and Arizona." Specimens were examined from Las Vegas, Nevada, labeled "*Hymenoclea salsola*."

Comparative Notes: The greenish color readily separates this species from any other in the genus found in the Southwest. The difference in the length of the crown is not always so great, as some short crowned females will be found, although never so short as in the males.

54. *Scaphytopius (Cloanthanus) nigriviridis dixianus* (Ball)

Platymetopius nigriviridis var. *dixianus*, Ball, E. D., Ent. News, XX: p. 163, 1909.

Resembles *nigriviridis* but brownish in color and with aedeagus longer and less curved. Length: female 4.5 mm., male 4 mm.

Color: Crown ivory to yellow with brown lineations on apical two-thirds; same color pattern as in *nigriviridis*. Pronotum ivory with vittae indicated by brown dots. Face as in *nigriviridis*, with the green replaced by yellow. Forewings more opaque ivory than *nigriviridis*, with most of wing, excepting brachial cell, containing brown clouded areas, especially in female; usually about three dark recurved veins in costa, others ivory to yellow.

Structural Characteristics: About the same as in *nigriviridis*, except usually with somewhat shorter crown.

Genitalia: About the same as in *nigriviridis* but with aedeagus in lateral view stout, almost parallel-margined, only slightly curved; and with paraphyses narrower near apex.

Types: Holotype female, St. George, Utah, July 24, 1908, in the National Museum, Washington, D. C., here designated. Allotype ♂ and 30 ♂ paratypes, Wickenburg, Ariz., July 27, 1933, R. H. Beamer, in the Snow Entomological Collections. Additional ♂ paratypes as follows: (Utah) 1, St. George, Sept. 28, 1928, E. W. Davis and 3, St. George, July 28, 1935, light trap. (California) 3, Palm Spgs., Dec. 22, 1941, R. H. Beamer and 1, Mt. Spgs., July 25, 1938, R. H. Beamer. (Arizona) 2, Tucson, June 18, 1933, R. H. Beamer; 5, Tucson, Nov. 19, 1931, and 1, Sept. 14, 1930, E. D. Ball; 4, Tucson, June 18, 1933, P. W. Oman; 7, Gila Bend, April 26, 1935, E. D. Ball; 19, Red Rock, Aug. 28, 1933, P. W. Oman; 2, Congress

Jct., Aug. 15, R. H. Beamer; 1, Ajo, July 23, 1938, R. H. Beamer and 3, Yuma, Oct. 30, 1931, E. D. Ball.

Host Plants: Ball (1932) writes "—has been taken sparingly from *Hymenoclea salsola* in the same regions."

Comparative Notes: Specimens collected in the winter have a somewhat shorter crown than those collected in the summer. This form seems to be restricted to Arizona and adjacent areas of California and Utah, a somewhat narrower range than for *nigriviridis*.

55. *Scaphytopius (Cloanthanus) heldoranus* (Ball)

Nasutoides heldoranus, Ball, E. D., Can. Ent., LXIII: p. 226, 1931.

Resembling *desertanus* but with large black spot near apex of crown and black lines to posterior margin and with genital paraphyses. Length: female 3.8 mm., male 3.4 mm.

Color: Crown white to ivory with large, irregular black blotch near apex and three black lines from this to base; usually a less distinct line inside each eye. Pronotum gray with dark dots, vittae usually faintly indicated. Scutellum white to ivory with a few dark markings along base and on disc. Face light with black dots, lightest on disc of clypeus, darkest behind eye and between anterior margin of eyes; line behind eye and long sharksmouth at least indicated. Forewings opaque white, scattered brown dots throughout; veins consisting of brown dots anteriorly, becoming black lines on costa and at apex.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, almost straight on each side of bluntly pointed apex; wedge short and an irregular circle. Pronotum about three-fourths as long as crown, slightly more than twice as broad as length at middle and about four and one-half times length behind eyes. Clypeus about two and one-half times as long as width at ocelli, slightly concave along sharksmouth, somewhat constricted at antennae. Clypellus stout, only slightly enlarged, if any, near apex. Face in lateral view distinctly convex. Forewing with typical venation, several vein-like markings in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about one and one-half times as wide as length at middle, posterior margin broadly rounded, anterior margin convex. Paraphyses long, straight and slender to sharp apices. Aedeagus small, "J"-shaped, slightly broadest near apex. Styles almost three times as long as basal width, sinuate near middle, slightly lobed on outer margin before finger-like apical process.

Last ventral segment of female about twice as wide as median length, lateral margins convergent, posterior margin convex, with a small, bluntly pointed, median process.

Types: Holotype ♀, allotype ♂, Tombstone, Arizona, June 15, 1930, E. D. Ball, in the National Museum, Washington, D. C. One pair of paratypes, Huachucfa Mts., June 15, 1930, E. D. Ball, on hand for study.

Additional Material Studied: (Arizona) Mustang Mts., Oak Creek Canyon, Tombstone, Huachucfa Mts. and Patagonia. (New Mexico) Organ, White City and Carlsbad. (Texas) Ft. Stockton, El Paso Co. and Marathon.

Host Plants: Ball (1932) writes "—breeding abundantly on the wild rubber plant (*Parthenium incanum*) in southeastern Arizona."

Comparative Notes: This small desert species is easily recognized by the opaque white forewings and the large black spot at apex of crown.

56. *Scaphytopius (Cloanthanus) vittifrons* Hepner

Scaphytopius (Cloanthanus) vittifrons. Hepner, L. W., Jour. Kan. Ent. Soc., XIX. p. 104, 1946.

A distinctively marked species, with fuscous-margined, light vitta from sharksmouth to apex of clypeus. Length: female 4.5 mm., male 3.7 mm.

Color: Crown mottled fulvous to brown with broad, fuscous-margined light vittae as follows: along anterior margin from eye to eye, wedge, a long vitta on disc on each side of median suture and an irregular area along median margin of each eye. Pronotum mottled yellow to fulvous with typical vittae distinct and dark-margined. Scutellum yellowish, darkest next each basal corner. Clypeus yellowish, mottled with brown, with fuscous-bordered light marks as follows: line along basal margin joining ocelli, sharksmouth, vitta from near sharksmouth to apex. Clypellus and lorae same color as clypeus, but with fewer dark markings. Genae about same as clypeus, with fuscous-bordered light vittae as follows: behind eye, from apex of eye to lateral margin and next lorae. Forewings opaque white with irregular dark fulvous or light brown clouded areas covering about half of entire wing; veins darkening posteriorly and on costa.

Structural Characteristics: Crown about twice as long as width between eyes, longest in female, anterior margin almost straight on each side of pointed apex; wedge about two-fifths length of crown.

Pronotum about three-fourths as long as crown, proportionately shorter in female, twice as wide as length at middle and three and two-thirds times length behind eye. Clypeus over twice as long as width at ocelli, lateral margins sinuate at antennae. Clypellus only slightly enlarged near apex. Face in lateral view slightly concave between anterior margin of eyes. Forewing with a few vein-like marks in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about three-fourths as long as greatest width, posterior margin convex on each side of bluntly pointed apex; anterior margin with short, broad lobe. Paraphyses long, slender and sharply pointed. Aedeagus in lateral view short, curved and almost parallel-margined. Styles almost four times as long as basal width, sinuate on basal third, small lobe on outer margin before long, slender process on apical third.

Last ventral segment of female almost twice as wide as length at middle, lateral margin slightly convex; posterior margin almost straight except for small median lobe.

Types: Holotype male, Concan, Texas, July 6, 1936, R. H. Beamer, in the Snow Entomological Collections. Allotype female, Chisos Mts., Texas, Sept. 19, 1938, D. J. and J. N. Knull, in the Knull Collection, Ohio State University, Columbus, Ohio. One ♀ paratype, El Paso Co., Texas, Aug. 30, 1940, D. J. and J. N. Knull.

Host Plants: The host plant is not known.

Comparative Notes: So far as known, this is the only species north of Mexico with the vitta on the middle of the clypeus, although there are several larger, similarly marked species in México.

57. *Scaphytopius (Cloanthanus) slossonae* (Van Duzee)

Platymetopius slossoni, Van Duzee, E. P., Ann. Ent. Soc. Amer., III: p. 222, 1910.

Resembles *acutus* but smaller, more slender, and with a sharper crown. Length: female 4.5 mm., male 4 mm.

Color: Crown fulvous with light markings as follows: thin line along anterior margin, wedge, long broad arcuate line on disc on each side of median suture and two pairs of dots on posterior margin. Light areas are thinly and irregularly lined with brown. Pronotum fulvous, much darker than crown, lightest along anterior margin, scattered brown dots, especially in male; vittae irregular but distinct. Pronotum yellow to fulvous with typical markings. Clypeus, clypellus and lorae yellow except on basal fourth; brown along basal margin between eyes except for long sharksmouth.

Genae lightest next clypeus, dark along lateral margins, vitta behind eye and near ocellus distinct. Forewing semihyaline fulvous with large milky aeroles throughout, heavy fuscous vermiculations in male, lighter in female, darkest on outer antepical and adjoining costa; veins fuscous in male, lighter in female.

Structural Characteristics: Crown about two and one-fourth times as long as width between eyes, anterior margin straight on each side of sharply pointed apex; wedge about half length of crown. Pronotum about three-fifths as long as crown, two and one-fourth times as wide as length at middle and three and one-half times length behind eyes. Clypeus almost two and one-half times as long as width at ocelli with slight or no constriction at antennae; shallow concavity along sharksmouth. Clypellus relatively slender and enlarged at apex. Face in lateral view concave between anterior margin of eyes. Forewing with vein-like markings in brachial cell, eight or nine recurved veins to costa and sometimes extra cross-veins in clavus.

Genitalia: Valve slightly wider than length at middle, posterior margin convex on each side of bluntly pointed apex; anterior margin with short median lobe. Paraphyses long, slender, pointed and parallel-margined. Aedeagus slender, almost parallel-margined, slightly curved near base. Styles almost four times as long as basal width, slightly sinuate on basal third, lobed on outer margin before short, slender, outwardly curved apical process.

Last ventral segment of female about three-fifths as long as greatest width, latero-posterior margin almost evenly rounded.

Types: I was unable to locate the types, but one of the Van Duzee series from Crescent City, Florida, was on hand for study.

Additional Material Studied: (Florida) Ft. Myers, Homestead, Cocoanut Grove, Crescent City, Cedar Keys, Sanford, Lacoochee, Fruitville, Yankeetown, Ft. Mead, Gainesville, La Belle, Palm Beach, St. Marys River, Clearwater, Wildwood, Ft. Pierce, Jacksonville, Edgewater and Dunnellon. (Louisiana) Opelousas.

Host Plants: Ball (1932) writes "—was taken—in abundance everywhere in Florida. In several places larvae and adults were found on pure stands of a narrow-leaved sunflower (*Helianthus angustifolius*)."

Comparative Notes: This species is occasionally confused with *cinereus* in Florida, but in *slossonae* the area between sharksmouth and basal margin of clypeus is darker than remainder of clypeus, while in *cinereus* it is about the same color as remainder of clypeus.

58. *Scaphytopus (Cloanthanus) rubellus* (Sanders and DeLong)

Platymetopus rubellus, Sanders and DeLong, Ann. Ent. Soc. Amer., XII: p. 231, 1919.

Resembling *acutus* but with more slender, pointed crown, reddish in color and with coiled genital paraphyses. Length: female 5 mm., male 4.5 mm.

Color: Crown mottled reddish-fulvous with yellowish markings as follows: thin line along anterior margin, wedge, arcuate vittae on disc often obsolete except at middle, typical spots along posterior margin. Pronotum about same color as crown, vittae usually indicated. Scutellum same as crown, light markings faintly indicated. Face reddish-fulvous, lightest on disc of clypeus, sharksmouth long, vitta behind eye and one near ocellus faint, but visible. Forewing semihyaline reddish-fulvous with light aeroles, especially at apex; veins concolorous, becoming fuscous at apex and on costa.

Structural Characteristics: Crown as long as width between eyes in male, longer in female, anterior margin straight to slightly concave on each side of sharply pointed apex; concavity along wedge and median suture; wedge very narrow and about half length of crown. Pronotum slightly more than half as long as crown, about two and one-fourth times as wide as length at middle and three and one-half times length behind eye. Clypeus about two and one-fourth times as long as width at ocelli in male, longer in female, shallow concavity along sharksmouth and very little constriction at antennae. Clypellus slightly enlarged near apex. Face in lateral view strongly concave between anterior margin of eyes. Forewing with vein-like marks in brachial cell, about nine recurved veins to costa and extra veins in clavus.

Genitalia: Valve almost as long as greatest width, posterior margin definitely convex on each side of bluntly pointed apex; anterior margin concave on each side of truncate lobe on median third. Paraphyses slender, a complete coil on outer half; apices sharp. Aedeagus in lateral view with slender, slightly curved shaft. Styles almost four times as long as basal width, sinuate near middle, lobe on dorsal margin before finger-like process on apical fourth.

Last ventral segment of female almost twice as wide as length at middle, lateral margins convex and slightly convergent; posterior margin notched on each side of distinct, rounded lobe on median fourth.

Types: Lectotype ♂, lectoallotype ♀, Battle Point, Virginia, June 22, 1918, Sanders, here designated, in the DeLong Collection Ohio State University, Columbus, Ohio.

Material Studied: (Florida) Jacksonville, Sanford, La Belle, Branford, Suwanee Spgs. and Ft. Mead. (Georgia) Okefenokee Swamp and Prattsburg. (Alabama) Prattsville. (Louisiana) Natchitoches Parish. (Tennessee) Clarksville. (South Carolina) Florence and McClellansville. (North Carolina) Rocky Point and Wilmington. (D. C.) Washington.

Comparative Notes: This reddish species with the very sharp, slender crown is quite distinctive. Most like *argutus* in color, it has a much more pointed crown.

59. *Scaphytopius (Cloanthanus) cinereus* (Osborn and Ball)

Platymetopius cinereus, Osborn and Ball, Proc. Iowa Acad. Sci., IV: p. 198, 1897.

Platymoideus oviedus, Ball, E. D., Can. Ent., LXIII: p. 227, 1931.

Platymetopius parvus, Lathrop, Ohio Jour. Sci., XVII: p. 122, 1917.

Resembles *acutus* but smaller, yellowish in color and markings of forewing consisting primarily of dots. Length: female 4.5 mm., male 4 mm.

Color: Crown yellowish with dark fulvous irrorations throughout, light markings indicated as follows: wedge, broken oblique lines from anterior margin to base next median suture and two pairs of dots on posterior margin, one next each eye and another on each side of median suture. Pronotum more darkly marked than crown, excepting distinct light vittae. Scutellum yellow with typical markings. Clypeus, clypellus and lorae yellow, excepting long sharksmouth, lighter; dark irrorations across clypeus between eyes. Genae irrorate with dark, lightest along margin of clypeus, vitta behind eye and shorter ones near ocellus and antenna, distinct. Forewing semihyaline white with a faint fulvous tinge, numerous dark dots throughout; veins darkening posteriorly.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, anterior margin almost straight on each side of pointed apex; wedge almost half length of crown. Pronotum about two-thirds as long as crown, two and one-half times as wide as length at middle and four times length behind eye. Clypeus slightly more than twice as long as width at ocelli, slightly constricted near antennae; shallow concavity along sharksmouth. Clypellus distinctly widest near apex. Forewing with vein-like marks in brachial cell, eight or nine recurved veins to costa and usually extra cross-veins in clavus.

Genitalia: Valve about as long as greatest width, posterior margin slightly convex and converging to a rounded apex; anterior margin concave on each side of rounded lobe on median third.

Paraphyses slender, coiled around aedeagus on outer half; apices very sharp. Aedeagus with wedge-shaped base, shaft in lateral view, broad, curved and bluntly pointed. Styles about three times basal width, sinuate near middle, dorsal margin lobed just before short, bluntly pointed, finger-like, apical process.

Last ventral segment of female one and two-thirds as wide as length at middle, lateral margins convex; posterior margin with small lobe on each side of median notch.

Types: Lectotype ♂, Ames, Iowa, June 4, 1896, in the Iowa State College collection, Ames, Iowa. Lectoallotype ♀, same data, here designated. These were on hand for study.

The types of *oviedus* are in the National Museum, Washington, D. C.

The types of *parvus* were destroyed in the Clemson College fire, but a paratype male was in the Osborn Collection, and DeLong has designated an allotype from his collection.

Material Studied: Many specimens from throughout the East from Texas to Minnesota eastward. This is probably the commonest grass species in this area.

Host Plants: Ball (1932) writes "Attention was called in the original description to the fact that this species is only found in open grasslands and it was, therefore, inferred that it was a grass feeding species. With the present knowledge of food habits of the group it appears more likely that the food plant will prove to be some one of the shrubs or shrub-like plants that are found in such situations. *P. parvus* Lathrop is apparently a synonym of this species as he states that the male has a right-angled vertex and the female is 4 mm. long with orange on scutellum, characters that apply to *cinereus* but not to what he described as *cinereus* in his South Carolina list.

"*P. oviedus* Ball. This species either has several host plants on which it is apparently equally at home or else several species, for which distinctive characters have not been discovered, are involved. The type material was taken along with the nymphs on a low mat forming heather—but either this or a closely allied species is abundant, both nymphs and adults, on a wire-stemmed Euphorbiaceae (*Chamaesyce* sp.) that forms large red mats in dry places and again on a finely branching aster-like plant abundant along the margins of wet places in Florida. *P. cinereus* of Lathrop's South Carolina list is no doubt this species as it is described as too small and too long-headed in the male for the true *cinereus* Osb. & Ball."

Fletcher (1980) writes "Grass in low places in old fields. Also grass in pine woods, Beaumont, Texas. Native grassland. Throughout year."

Osborn writes, "It appears to develop especially on three different kinds of grasses, *Andropogon scoparius*, Michx., *Bouteloua hirsuta* Lag. and *curtipendula* (Michx.) Torr., the latter two species probably being its most common hosts."

Comparative Notes: Ball separates *oviedus* from *cinereus* by size and the presence of orange on the scutellum of *cinereus* but there was much gradation in size, and color of scutellum did not necessarily hold true. As one examined a series, it was found that the ones in Florida are the smallest and those further north the largest, just as the case in some other species, especially *frontalis*.

60. *Scaphytopius (Cloanthanus) guterranus* (Ball)

Platymoides guterranus, Ball, E. D., Can. Ent., LXIII: p. 226, 1931.

Resembling *acutus* but smaller and with numerous irrorations on crown. Length: female 4.5 mm., male 4 mm.

Color: Crown mottled fuscous and light, excepting light markings as follows: wedge, broken oblique line from anterior margin half-way between eye and wedge to posterior margin on each side of median suture; on posterior margin two pairs of spots, one next each eye and one on each side of median suture. Pronotum same color as crown, vittae irregular, but usually present. Scutellum fulvous to orange with typical markings present. Clypeus ivory to light fulvous, dark irrorations between anterior margin of eyes excepting white sharksmouth. Clypellus and lorae about same color as clypeus, usually some irregular dark clouded areas; apex of clypellus darkened. Genae darker than clypeus, somewhat mottled, vitta behind eye and shorter ones near ocellus and antenna, distinct. Forewing semihyaline light fulvous with lighter aeroles, although often fulvous areas are reduced and most of wing is light; dark irrorations throughout; veins brown, becoming fuscous at apex and on costa.

Structural Characteristics: Crown one and one-half times as long as width between eyes in male, longer in female; anterior margin almost straight on each side of pointed apex; wedge about one-third length of crown. Pronotum about two-thirds as long as crown in male, half as long as crown in female, slightly over twice as wide as length at middle and three times length behind eye. Clypeus about two and one-half times as long as width at ocelli, shallow concavity

along sharksmouth, slightly sinuate at antennae. Clypellus enlarged near apex. Face in lateral view slightly concave between eyes. Forewing with several vein-like marks in brachial cell and eight or nine recurved veins to costa.

Genitalia: Valve about as long as greatest width, posterior margin distinctly convex on each side of a truncate lobe on median third. Plates slender. Paraphysis slender, extending slightly beyond apex of plates, apex pointed. Aedeagus in lateral view very short, slightly curved and parallel-margined. Styles about four times as long as basal width, almost parallel-margined to rounded outer margin before sharply pointed apical process.

Last ventral segment of female about twice as wide as length at middle, lateral margins slightly convergent, posterior margin rounded to a very small median notch.

Types: Holotype ♀, allotype ♂, Yarnell Hts., Ariz., Oct. 8, 1929, E. D. Ball, in National Museum, Washington, D. C. One pair of paratypes, same data, on hand for study.

Additional Material Studied: (Utah) Smithsfield. (Arizona) Coconino Co., Flagstaff, Sunset Pk., Yarnell, Yavapai Co., Navajo Co., St. Johns, Grand Canyon, Williams, Ashfork, Granite Dell, Kaibab and Safford. (New Mexico) Tijique, Mountain Park, Santa Fe, Las Vegas, Silver City and Jemez Spgs.

Host Plants: Ball (1932) writes "Nymphs and adults of this species were found in abundance on *Gutierrezia californica* in northern Arizona."

Comparative Notes: The relatively long crown, almost entirely covered with vermiculations, resembles no other species with the possible exception of the much larger *trilineatus*.

61. *Scaphytopius (Cloanthanus) acutus* (Say)

Jassus acutus, Say, Jour. Acad. Nat. Sci. of Phil., VI: p. 306, 1831.

Jassus modestus, Of. Vet. Akad. Forh., XI: p. 255, 1854.

Platymetopus acutus var. *dubius*, Van Dusee, E. P., Ann. Ent. Soc. Amer., III: p. 220, 1910.

Cloanthanus filamentus, DeLong, D. M., Ohio Jour. Sci., XLV: p. 23, 1945.

Cloanthanus tenuis, DeLong, D. M., Ohio Jour. Sci., XLV: p. 23, 1945.

Resembles *latus* but with different pattern on a shorter crown and with genital paraphyses almost parallel-margined. Length: female 5.2 mm., male 4.8 mm.

Color: Crown mottled fulvous with light markings as follows: thin, broken line along anterior margin; wedge; arcuate or straight line on disc from near apex to base on each side of median suture;

two pairs of dots along posterior margin, one next each eye and another next median suture, the latter are often united. Pronotum darker than crown, lightest along anterior margin, few irrorations, vittae evident. Scutellum yellow to orange with typical light markings. Clypeus, clypellus and lorae bright yellow excepting brown irrorations on both sides of yellow sharksmouth and black line along apex of clypellus. Genae fuscous except for broad area next clypeus, vitta behind eye and shorter one near ocellus. Forewing semihyaline fulvous with fuscous dots and vermiculations, excepting milky aeroles throughout; veins brown, becoming fuscous to black at apex and on costa.

Structural Characteristics: Crown slightly over one and one-half times as long as width between eyes, slightly convex on each side of bluntly pointed apex; wedge about one-third length of crown. Pronotum slightly shorter than crown, about two and one-fourth times as wide as length at middle, and three and one-half times length behind eyes. Clypeus about twice as long as width at ocelli, slightly constricted at antennae. Clypellus enlarged near apex. Forewings with vein-like marks in brachial cell and eight or nine recurved veins to costa.

Genitalia: Valve about one and one-fourth as wide as length at middle, posterior margin convex near bluntly pointed apex; anterior margin rounded. Paraphyses with basal bulb-like enlargement, slightly enlarged on outer half before sharp apices. Aedeagus "J"-shaped, narrowest on outer third before bluntly pointed apex. Valves long, about four times as long as basal width, slightly sinuate near basal third, slightly lobed on outer margin with a sharply pointed process on apical fifth; a small process on outer margin just before apical process. Pygofer with broad concavity on outer margin on basal half.

Last ventral segment of female one and three-fifths as wide as length at middle, lateral margins slightly convergent, posterior margin slightly convex with a slight median notch.

Types: Evidently the Say types of this species have been lost or destroyed. DeLong (1945) erected a neotype, which is in his collection.

Host Plants: DeLong (1923) writes "may be found on *Calamagrostis canadensis* in a wet meadow habitat." Lowry (1933) reports "grasses and sedges" as the hosts. Osborn (1915) writes "—from bushes, grass and sweet fern—willows, potato and various plants." This species is apparently found on a large number of hosts.

Comparative Notes: This species is the most variable one in the genus, both in external characters and internal genitalia. Color may vary from almost black to a light fulvous, the crown may vary considerably in length, and the lorae may vary from almost black to fulvous. The styles vary from long to rather short. The only constant character is the broadly concave margin of the pygofer on basal half, often the only character that will separate this species from similar ones. Several attempts were made to separate this species into subspecies, but there are gradations from one extreme to the other. Until more is known regarding the host relationships, it is best to consider them as one species, especially with the good character furnished by the outer margin of the pygofer.

62. *Scaphytopius (Cloanthanus) oregonensis* (Baker)

Platymetopius oregonensis, Baker, Can. Ent., XXXII: p. 49, 1900.

Resembling *acutus* but larger, lighter in color, margins of face not infuscated and with shorter crown. Length: female 6 mm., male 5.5 mm.

Color: Crown fulvous with brown irrorations, light markings, as follows: thin line along anterior margin, wedge, indistinct, irregular arcuate line on each side of median suture on disc. Pronotum about same color as crown but with few or no irrorations, vittae usually evident only on lateral margins. Scutellum slightly darker than crown with typical light markings. Clypeus, clypellus and lorae ivory to yellow, excepting distinct long sharksmouth and dark dots between this and posterior margin. Genae fulvous, darkest on lateral margins, vitta behind eye and shorter one near ocellus distinct. Forewings semihyaline fulvous with milky aeroles throughout, especially on costa; veins concolorous near base, becoming brown to fuscous at apex and on costa.

Structural Characteristics: Crown of male about one and one-third times width between eyes, longer in female, anterior margin straight to slightly convex on each side of pointed apex; wedge almost half length of crown. Pronotum about two-thirds as long as crown, two and one-fourth times as wide as length at middle and three and one-half times length behind eyes. Clypeus slightly over twice as long as width at ocelli, only slightly constricted at ocelli, shallow concavity along sharksmouth. Clypellus slender, only slightly enlarged near apex. Face in lateral view straight in male, slightly concave between antennae in female. Forewings with

several vein-like markings in brachial cell, about nine recurved veins to costa and often extra cross-veins in clavus.

Genitalia: Valve slightly wider than length at middle, roughly triangular, posterior margin almost straight on each side of bluntly pointed apex; anterior margin with short, broad, median lobe. Paraphyses stout, broadest near outer fourth before sharp apices. Aedeagus in lateral view narrowest at base, broadest near middle; apex bluntly pointed. Styles short, about two and one-half times as long as basal width, sinuate just before middle, lobed on outer margin before sharply pointed process on apical fifth.

Last ventral segment of female almost as long as basal width, lateral margins somewhat converging, posterior margin rounded.

Types: Dr. P. W. Oman writes regarding the type of this species, "Oreg. 2509 Collection Carl F. Baker. Associated notes indicate that this specimen was collected at Portland, Ore., 9-18-97, A. P. Morse." This male specimen in National Museum, Washington, D. C. Allotype female, Canyonville, Ore., July 12, 1935, R. H. Beamer, here designated, in the Snow Entomological Collections. Paratype ♀ ♀, as follows: (California) 3, Santa Cruz Mts., Aug. 13, 1938, R. I. Sailer; 1, Santa Cruz Mts., Aug. 13, 1938, R. H. Beamer; 10, Santa Rosa, Aug. 16, 1938, R. H. Beamer; 1, Santa Rosa, Aug. 16, 1938, D. W. Craik; 4, Santa Rosa, Aug. 16, 1938, L. W. Hepner; 5, Jamesburg, Aug. 11, 1938, R. H. Beamer; 4, Jamesburg, Aug. 11, 1938, L. W. Hepner; 2, Jamesburg, Aug. 11, 1938, R. I. Sailer; 5, Lockwood, July 24, 1935, R. H. Beamer; 3, Dunsmuir, June 29, 1935, R. H. Beamer; 1, Dunsmuir, Aug. 13, 1912, E. D. Ball; 1, Dunsmuir, June 28, 1935, P. W. Oman; 3, Towie, Aug. 20, 1938, R. H. Beamer; 2, Towie, Aug. 20, 1938, R. I. Sailer; 3, Lompoc, Aug. 7, 1938, R. I. Sailer; 1, Occidental, Aug. 16, 1938, R. H. Beamer; 1, Niles, July 15, 1933, R. H. Beamer and 1, Redding, June 29, 1933, P. W. Oman. (Oregon) 7, Le Grand, Aug. 29, 1909, E. D. Ball; 1, Le Grand, July 16, 1921, E. W. Davis; 2, Medford, Aug. 14, 1912, E. D. Ball and 1, Ashland, Aug. 13, 1912, E. D. Ball. (Washington) 6, Wenatchee, Aug. 18, 1912, E. D. Ball. (Idaho) 2, Moscow Mt., Sept. 15, 3, Sept. 18 and 1, Sept. 24, J. Gillette. (Utah) 2, Logan Canyon, Sept. 9, 1934, T. O. Thatcher; 3, Logan Canyon, Aug. 21, 1934, Smith and Thatcher and 1, Logan Canyon, July 31, 1933, G. F. Knowlton. (Montana) 1, Missoula, Aug. 11, 1931, R. H. Beamer. (British Columbia) 1, Vernon, Aug. 5, 1931, R. H. Beamer.

Host Plants: Specimens were examined with the following host data on them: *Arctostaphyleae mansanita*, Occidental, Calif.; *A.*

patula, Towie, Calif.; *Holodiscos discolor*, *Medicago sativa*, *Ceanothus sanguineus* and *Pteridium aquilium*, Moscow Mts., Idaho, and buck brush, Logan Canyon, Utah. Ball (1932) writes "—was swept by the writer both larvae and adults in abundance from mixed clumps of wild roses and snowberries (*Symphoricarpos*) at Wenatchee and Le Grand, Oregon."

Comparative Notes: There is a light *acutus* in the same range with *oregonensis* but the latter species has a shorter crown, is larger and lacks the concavity on the outer margin of the male pygofer. The males are sometimes quite dark and are almost invariably darker than females.

63. *Scaphytopius (Cloanthanus) latus* (Baker)

Platymetopius latus, Baker, Can. Ent. XXXII: p. 50, 1900.

Platymetopius cuprescens, Osborn, Report of N. Y. St. Entomologist, p. 517, 1905.

Resembles *acutus* but with less distinct markings on a longer crown, lighter on margins of genae, shorter male plates and longer last ventral segment of the female. Length: female 5.5 mm., male 5 mm.

Color: Crown fulvous, darkest on disc with light wedge and sometimes faintly evident, long arcuate marks on disc. Pronotum about same color as disc of crown, lightest along anterior margin. Scutellum fulvous, darkest next each basal corner, typical markings distinct. Face yellow to fulvous, darkest on lateral margin and along base of clypeus; long sharksmouth faint but distinct. Forewing fulvous on clavus, darker on corium, dark vermiculations on corium, light aeroles near apex, darkest on outer anteapical; veins fulvous, becoming brown to fuscous at apex and on costa.

Structural Characteristics: Crown about twice as long as width between eyes, somewhat concave on disc, straight on each side of rounded, but acutely pointed apex; wedge about one-third length of crown. Pronotum slightly more than twice as wide as length at middle, three and one-half times length behind eyes. Clypeus about two and one-fourth times width at ocelli, only slightly constricted at antennae; shallow concavity along sharksmouth. Clypellus relatively broad and slightly enlarged near apex. Face in lateral view slightly concave between anterior margin of eyes. Forewing with numerous vein-like marks in brachial cell, about twelve recurved veins to costa and usually extra cross-veins in clavus.

Genitalia: Valve about one and one-third as wide as length at middle, posterior margin oval; anterior margin with relatively large

truncate, median lobe. Paraphyses stout, bulb-like, basal area elongate, greatly enlarged on outer fifth; spine-like process at apices. Aedeagus in ventral view narrowest on outer half. Styles stout, two and one-half times as long as basal width, sinuate near basal third, lobed on outer margin before stout, bluntly-pointed process on apical third.

Last ventral segment of female about one and one-third as wide as length at middle, lateral margins converging, posterior margin with broad lobe on each side of small median notch.

Types: Holotype ♀, "Colo. 882, Collection Carl F. Baker, Collected Ft. Collins, Colo., 8-11." in the National Museum, Washington, D. C. Allotype ♂, here designated, "Colo." (only data) in Snow Entomological Collections. Parallotype ♂♂ as follows: (Utah) 1, Ogden, July 24, 1912. (North Dakota) 1, Lake Metigoshe, July 30, 1937, R. H. Beamer. (Minnesota) 2, Fairbanks, Aug. 13, 1937, R. H. Beamer; 2, Eveleth, Aug. 12, 1937, R. H. Beamer; 1, St. Anthony Peak, June 28, 1910, "E. P." and 1, Cook Co., Aug. 21, 1938, H. T. Peters. (Wisconsin) 3, Brule, Aug. 16, 1937, R. H. Beamer; 1, Cheboygan Co., July 16, 1936, M. W. Sanderson; 1, Cheboygan Co., July 14, 1931, H. B. Hungerford and 1, Cheboygan Co., July 11, 1933, Harold Peters. (New Hampshire) 1, Notchland, Aug. 20, 1934, R. H. Beamer. (Canada) 2, Newaygo, July 30, 1929, Parrish. (Manitoba) 1, Russell, Aug. 1, 1937, R. H. Beamer; 2, Birch River, Aug. 3, 1937, R. H. Beamer and 1, Mafeking, Aug. 3, 1937, R. H. Beamer.

Host Plants: Material examined from Itasca Park, Minnesota, were collected on *Pinus banksiana*.

Comparative Notes: This species is apparently rare in Colorado and Utah, but is rather common in the Northeast and has been known as *cuprescens* Osborn.

64. *Scaphytopius (Cloanthanus) argutus* De Long

Cloanthanus argutus, DeLong, D. M., Ohio Jour. Sci., XLV: p. 24, 1945.

Scaphytopius hastus, DeLong, D. M., Ohio Jour. Sci., XLV: p. 24, 1945.

Scaphytopius lanceus, DeLong, D. M., Ohio Jour. Sci., XLV: p. 24, 1945.

Resembling *acutus* but lighter along margins of genae, darker outer wings, and paraphyses enlarged near apex. Length: female 5 mm., male 4.5 mm.

Color: Crown fulvous, sometimes darkest on disc with light markings as follows: thin line along anterior margin, wedge, long arcuate ~~vitta~~ on each side of median suture and usually two pairs of large dots along posterior margin. Pronotum usually darker than

crown, typical vittae usually faintly indicated. Scutellum about same color as crown, with typical markings. Clypeus, clypellus and lorae yellow to fulvous, darkest along posterior margin excepting long sharksmouth. Genae darker than clypeus, lightest next clypeus, and vitta behind eye and near ocellus distinct. Forewing opaque fulvous to reddish-fulvous with white aeroles at apex of clavus and apex of corium, dark vermiculations; veins fuscous.

Genitalia: Valve about one and one-fourth times as wide as length at middle, posterior margin rounded to bluntly pointed apex; anterior margin concave on each side of broad, rounded lobe on median third. Paraphyses extending well beyond plates and, except for basal bulb, almost parallel-margined to outer fourth, where they are enlarged, long, plate-like, before sharp apices. Aedeagus in ventral view, much narrower near apex, in lateral view with short, broad "arrow head"—like basal process and slightly curved shaft, narrowed to a blunt apex. Styles about three times as long as basal width, sinuate near middle, long lobe on dorsal margin just before finger-like apical process.

Types: Types of *argutus* and *lanceus* in the DeLong collection, Ohio State University, Columbus, Ohio. Types of *hastus* in Illinois Natural History Survey collection, Urbana, Illinois. Holotype of *argutus*, and paratypes of *lanceus* and *hastus* on hand for study.

Additional Material Studied: (Florida) Hilliard. (Georgia) Prattsburg and Griffin. (Alabama) Burnsville and Tuskegee. (Mississippi) Fulton, Ireland, and Shuqulak. (Louisiana) Caddo Parish. (South Carolina) Tigerville and Lexington. (Tennessee) Clarks-ville, Magnolia, Coal Creek, Elk Valley and Chattanooga. (North Carolina) Walnut. (Kentucky) Cadiz. (Arkansas) Polk Co. (Indiana) Gary.

Host Plants: The host plant is not known.

Comparative Notes: This species varies a great deal in size, color and with some variation in the male genitalia. The distinctive characters are the brownish, almost opaque wings, the fulvous face and the aedeagus much smaller at apex than at middle, when viewed from ventral side. Sometimes the crown is lighter than forewings.

65. *Scaphytopius (Cloanthanus) fuscicephalus* Hepner

Scaphytopius (Cloanthanus) fuscicephalus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX, p. 105, 1946.

Resembles *argutus* but with crown darkest on disc and aedeagus straight and parallel-margined in ventral view. Length: female 4.8 mm., male 4.1 mm.

Color: Crown mottled fulvous and brown, darkest on disc; wedge light. Pronotum fulvous flecked with dark, vittae evident. Scutellum dark fulvous, darkest near basal corner, typical markings present. Face yellowish, slightly darker behind eyes and along basal margin between ocelli, with dark-margined light markings as follows: sharksmouth, vitta behind eye and shorter one near ocellus. Forewings translucent brown; veins and many vermiculations, darker; white aeroles throughout.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin almost straight on each side of sharply pointed apex; wedge about two-fifths length of crown. Pronotum about three-fifths as long as crown, two and one-fourth times as wide as length at middle and three and one-half times length behind eye. Clypeus slightly more than twice as long as width at ocelli, only slightly, if any, sinuate at antennae. Clypellus only slightly enlarged near apex. Face in lateral view concave between anterior margin of eyes. Forewings often with extra veins in clavus, vein-like markings in brachial cell and about ten recurved veins to costa.

Genitalia: Valve about three-fourths as long as greatest width, posterior margin bell-shaped; anterior margin with broad, short, median lobe. Paraphyses long, slender and only slightly enlarged near apices. Aedeagus in ventral view parallel margined; in lateral view slightly curved near base. Styles about two and one-half times as long as basal width, sinuate near middle, lobed on outer margin before finger-like process on apical third.

Last ventral segment of female almost twice as wide as median length, latero-posterior margin rounded.

Types: Holotype ♂, allotype ♀, Lawrence, Kansas, Sept. 4, 1941, L. W. Hepner, in the Snow Entomological Collections. Paratypes as follows: (Kansas) 1 ♂, Cherokee Co., Apr. 9, 1938, R. H. Beamer; 1 ♂, Coffeyville, June 15, 1939, 1 ♂, June 24, 1939, and 1 ♂, July 16, 1939, L. W. Hepner; 1 ♀, Douglas Co., July, 1926, E. L. Bales; 1 ♂, Douglas Co., Aug. 28, 1928, 1 ♂, Aug. 17, 1928 and 1 ♂, June 21, 1928, P. B. Lawson; 4 ♀ ♀, Atchison Co., July 8, 1924, E. P. Breakey.

Host Plants: The host plant is not known.

Comparative Notes: Specimens were on hand from Texas and New Mexico which were evidently of this species. It is separated from *argutus* by the different aedeagus and much darker crown.

66. *Scaphytopius (Cloanthanus) viridicephalus* Hepner

Scaphytopius (Cloanthanus) viridicephalus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 108, 1946.

Resembling *slossonae* but with shorter, greenish crown, and darker male. Length: female 4.2 mm., male 3.6 mm.

Color: Crown greenish-fulvous, especially in female, with wedge, long arcuate markings on disc and two pairs of large dots on posterior margin at least indicated. The male often is only faintly tinged with green, but may be distinguished from other species by the crown being much lighter than the forewing. Pronotum darker than crown, sparsely punctate with dark in the male, vittae distinct. Scutellum about same color as pronotum with typical light markings present. Face greenish-fulvous in female, light green in male, slightly darkest along lateral margin of genae, long sharksmouth, vitta behind eye and another near ocellus faintly indicated. Forewing of male semihyaline fulvous with dark vermiculations throughout, very dark on apex, veins concolorous at base, darkening and becoming fuscous at apex and on costa. Forewing of female bright fulvous throughout, a few milky aeroles throughout, no vermiculations; veins concolorous. Occasionally a female with one or two recurved veins darkened will be found.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin straight on each side of pointed apex; wedge over one-third length of crown. Pronotum about three-fifths as long as crown, two and one-half times as wide as length at middle and four and one-half times length behind eye. Clypeus about two and one-fourth times width at ocelli, only slightly constricted at antennae. Clypellus definitely enlarged near apex. Face in lateral view almost straight. Forewing with about seven recurved veins to costa, claval veins approaching each other at cross vein and sometimes extra cross veins in clavus.

Genitalia: Valve about one and one-fourth as wide as length at middle, posterior margin convex on each side of bluntly pointed apex; anterior margin slightly concave on each side of median lobe. Paraphyses with basal, bulb-like enlargement, almost parallel-margined to enlargement near sharp apices. Aedeagus in lateral view, slightly curved, smallest near blunt apex. Styles stout, about three times as long as basal width, sinuate just before middle, lobed on dorsal margin before finger-like process on apical third.

Last ventral segment of female about twice as wide as length at middle, latero-posterior margin rounded to a small median lobe.

Types: Holotype ♂, allotype ♀ and 4 ♂ and 8 ♀ paratypes, Shuqualak, Mississippi, July 16, 1930, P. W. Oman, in the Snow Entomological Collections. Additional paratypes as follows: (Mississippi) 2 ♂ ♂, Shuqualak, July 16, 1930, R. H. Beamer; 1 ♀, Shuqualak, July 16, 1930, L. D. Tuthill; 1 ♀, Meridian, July 17, 1930, L. D. Tuthill; 1 ♀, Hamilton, July 15, 1930, R. H. Beamer; 1 ♀, Fulton, July 14, 1930, R. H. Beamer and 1 ♂, Columbus, July 16, 1930, R. H. Beamer. (Alabama) 1 ♀, Marion Jct., July 16, 1930, R. H. Beamer. (Texas) 2 ♂ ♂, Brownsville, Dec. 27, 1945, and 2 ♀ ♀, June 29, 1938, R. H. Beamer; 8 ♀ ♀, 1 ♂, Brownsville, May 25, 1939, and 1 pr., Aug. 8, 1937, D. J. and J. N. Knull; 11 ♀ ♀, 8 ♂ ♂, Brownsville, May 31, 1933, and 19 ♀ ♀, 24 ♂ ♂, May 29, 1933, P. W. Oman and 2 ♀ ♀, Benchley, April 30, 1941, D. J. and J. N. Knull.

Host Plants: The host plant is not known.

Comparative Notes: In some of the series, some specimens have a distinctively green head, while others will hardly be green at all, but a dark fulvous in the male, lighter in the female.

67. *Scaphytopius (Cloanthanus) utahensis* Hepner

Scaphytopius (Cloanthanus) utahensis, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 107, 1946.

Resembling *graneticus* but larger, somewhat lighter in color, with broader aedeagus and paraphyses. Length: female 5 mm., male 4.8 mm.

Color: Crown fulvous flecked with brown, darkest next median suture, except for light markings as follows: line along anterior margin, wedge, long arcuate line on disc on each side of median suture. Pronotum fulvous flecked with dark, vittae irregular but present. Scutellum fulvous with a few irregular brown markings on basal half and a large brown spot inside each basal corner. Face light fulvous to yellow, with fuscous-bordered light markings as follows: sharksmouth, vitta behind eye and a shorter one in front of eye near ocellus. Forewing semihyaline fulvous with veins and many vermiculations, brown.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin almost straight on each side of apex. Pronotum about two-thirds as long as crown, two and one-fourth times as wide as length at middle and three and one-half times length behind eye. Clypeus about two and one-third times as long as width at ocelli, lateral margins slightly sinuate at antennae. Clypellus

slender, only slightly enlarged near apex. Face in lateral view straight. Forewing with vein-like marks in brachial cell and about twelve recurved veins to costa.

Genitalia: Valve almost as long as greatest width, posterior margin oval, anterior margin with broad, short, truncate lobe. Paraphyses slender on basal three-fifths, gradually enlarged almost to sharp apices. Aedeagus in ventral view almost parallel-margined; in lateral view, long, curved near base, almost parallel-margined to blunt apex. Styles almost four times as long as basal width, sinuate near middle, lobed on outer margin before short, slender finger-like apical process.

Last ventral segment of female about one and one-half times as wide as median length, latero-posterior margin rounded, slightly notched at middle.

Types: Holotype ♂, allotype ♀, and 4 ♀ and 1 ♂ paratypes, Alton, Utah, Aug. 11, 1936, R. H. Beamer, in the Snow Entomological Collections.

Host Plants: The type series was collected on *Rhus* sp.

Comparative Notes: This species is a tannish color and rather more slender than related species.

68. *Scaphytopius (Cloanthanus) graneticus* (Ball)

Platymoideus graneticus, Ball, E. D., Can. Ent., LXIII: p. 226, 1931.

Resembling *acutus* but smaller, with lateral margins of genae lighter and pygofer without basal concavity on outer margin. Length: female 4.8 mm., male 4.3 mm.

Color: Crown mottled fulvous and brown, often darkest on disc; light markings as follows: thin, sometimes broken line along anterior margin, wedge, long arcuate vitta on disc on each side of median suture and usually four large dots on posterior margin. Pronotum about same color as crown, darkest on disc, typical light vittae at least indicated. Scutellum yellow to orange with typical light markings. Clypeus, clypellus and lorae yellow, excepting brown markings around long sharksmouth and along posterior margin between eyes. Genae yellow next clypeus, darkening and becoming fulvous on lateral margins; vitta behind eye and near ocellus, distinct. Forewing semihyaline fulvous with many brown vermiculations, especially in male; veins darkening posteriorly, becoming black on costa.

Structural Characteristics: Crown about twice as long as width

between eyes in female, shorter in male, anterior margin straight on each side of sharp apex; wedge over one-third length of crown. Pronotum about two-thirds as long as crown; two and one-third times as wide as length at middle and about three and one-half times length behind eyes. Clypeus about two and one-half times width at ocelli, constricted at antennae, concave along sharksmouth. Clypellus relatively slender and somewhat enlarged near apex. Face in lateral view straight to slightly concave between anterior margin of eyes. Forewings with several vein-like markings in brachial cell, about ten recurved veins to costa and often extra cross-veins in clavus.

Genitalia: Valve about one and one-third times as wide as length at middle, posterior margin convex on each side of rounded apex; anterior margin rounded. Paraphyses slender, with relatively small basal, bulb-like enlargement; enlarged on apical fourth before sharp apex. Aedeagus in lateral view, slender, slightly larger and curved on basal half. Styles about three times as long as basal width, sinuate near middle, lobe on outer margin before slender, finger-like process on apical fifth.

Last ventral segment of female about one and two-thirds as wide as length at middle, latero-posterior margin evenly oval.

Types: Holotype ♀, Granite Dell, Ariz., July 17, 1929, allotype ♂, Williams, Arizona, Aug. 15, 1929, E. D. Ball, in the National Museum, Washington, D. C. One pair of paratypes, same data as holotype, on hand for study.

Additional Material Studied: (Arizona) Prescott, Yavapai Co., Granite Dell, Oak Creek Canyon and Kaibab Forest. (California) Leona Hts., Alameda Co., Lemon Cove, Redding, Delta, Big Bear Lake, Dunsmuir, Mint Canyon, Santa Rosa, Atascadero, Alpine and Stinton Beach.

Host Plants: Ball (1932) writes "Females of this species were taken in some numbers from wild grapes near Prescott, Arizona, July 17. It was apparently the last end of a brood as there were no nymphs or males present at that time. A single male was taken from wild grapes in the mountains above Williams, Arizona, Aug. 15."

Comparative Notes: This species is somewhat like *argutus* from the East, but the genitalia are somewhat different. It varies considerably, the specimens from California being much darker than those from Arizona.

69. *Scaphytopius (Cloanthanus) canus* Hepner

Scaphytopius (Cloanthanus) canus, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 107, 1946.

Resembling *trilineatus* but larger, lighter in color, with a light face and genital paraphyses much larger near apex. Length: female 6 mm., male 5.6 mm.

Color: Crown light fulvous with brown irrorations, light markings as follows: line along anterior margin, wedge, irregular arcuate line on disc on each side of median suture and an indication of another line parallel to this just inside eyes. Pronotum usually slightly darker than crown, darkest on disc and sparsely sprinkled with brown dots; vittae usually evident only on lateral margins. Scutellum about same color as crown with typical markings. Clypeus, clypellus and lorae light fulvous, except for sharksmouth and irregular brown markings along base of clypeus; apex of clypellus brown. Forewings light fulvous with brown dots throughout; veins fulvous, becoming fuscous on costa.

Structural Characteristics: Crown about twice as long as width between eyes in male, slightly longer in female, anterior margin almost straight on each side of slender, but bluntly pointed apex; wedge almost half length of crown. Pronotum slightly over half length of crown, about two and one-half times length behind eyes. Clypeus almost two and one-half times width at ocelli, slightly sinuate at antennae; shallow concavity along sharksmouth. Clypellus stout, slightly enlarged near apex. Face in lateral view slightly concave between anterior margin of eyes. Forewings with many vein-like marks in brachial cell, about twelve recurved veins to costa and often extra veins in clavus.

Genitalia: Valve about three-fourths as long as greatest width, posterior margin straight on each side of bluntly pointed apex, anterior margin convex. Paraphyses enlarged near sharp apices. Aedeagus "J"-shaped, almost parallel-margined throughout. Styles over twice as long as basal width, sinuate near middle, distinct lobe on outer margin before rather small apical process.

Last ventral segment of female about three-fourths as long as greatest width, convex and converging on lateral margins; posterior margin straight.

Types: Holotype ♂, allotype ♀, 10 ♀ and 11 ♂ paratypes, Pine Valley, California, July 27, 1938, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (Cali-

foria) 2 ♀ ♀, Quatay, July 19, 1941, R. H. Beamer; 1 ♀, Santa Cruz Mts., Aug. 13, 1938, R. H. Beamer.

Host Plants: The type series was collected on *Garrya veatchii* which is probably the host plant.

Comparative Notes: This species resembles *trilineatus*, but has a shorter crown and the face is light. The general color is much lighter than *trilineatus*. It is evidently restricted to southern California.

70. *Scaphytopius (Cloanthanus) trilineatus* (Ball)

Platymetopius trilineatus, Ball, E. D., Ent. News, XXVII: p. 204, 1916.

Platymetopius pezatus, Van Dusee, E. P., Proc. Calif. Acad. Sci., XLI: p. 415, 1925.

Resembles *acutus*, but with longer crown, dark face and distinct genitalia. Length: female 5.2 mm., male 5 mm.

Color: Crown mottled brown or fuscous and ivory, with light areas as follows: relatively broad line along anterior margin; wedge; irregular arcuate line from near apex to base on each side of median suture; two pairs of large dots on posterior margin, one next each eye and another on each side of median suture, often continuous with the long arcuate vittae on disc. Pronotum about the same color as crown with vittae fairly distinct. Scutellum fulvous to brown with typical markings. Face brown to reddish-brown with small light dots throughout, lightest on long sharksmouth and coarse vermiculations along base between eyes; darkest on lateral margin of genae; vitta behind eye and shorter ones near ocellus and antenna distinct. Forewing opaque fulvous on disc, apex and part of clavus, remainder semihyaline white in patches, scattered vermiculations throughout; veins dark.

Structural Characteristics: Crown almost two and one-half times as long as width between eyes, anterior margin almost straight on each side of sharp apex; disc somewhat concave; wedge over half length of crown. Pronotum slightly less than half as long as crown, two and one-third times as wide as length at middle and four times length behind eyes. Clypeus over two and one-half times as long as width at ocelli, definitely constricted at antennae; concavity along sharksmouth. Clypellus somewhat enlarged near apex. Face in lateral view somewhat concave between anterior margin of eyes. Forewings with several vein-like marks in brachial cell, about eleven recurved veins to costa and usually extra cross-veins in clavus.

Genitalia: Valve about seven-tenths as long as greatest width, posterior margin rounded; anterior margin with broad, short median

lobe. Paraphyses long, slender and hardly enlarged at all before sharp apices. Aedeagus roughly "L"-shaped, short, almost parallel-margined throughout. Styles slender, over twice as long as basal width, small lobe on outer margin before process on apical fifth.

Last ventral segment of female about three-fourths as long as greatest width, lateral margins straight and converging; posterior margin straight and converging on each side of a shallow, slender median notch.

Types: Holotype ♂, San Margareta, Calif., Aug. 6, 1912, E. D. Ball, in the National Museum, Washington, D. C. Allotype ♀ and 12 ♀ paratypes, Anza, California, July 29, 1938, R. H. Beamer, in the Snow Entomological Collections. Additional ♀ paratypes as follows: 1, Anza, July 29, 1938, R. I. Sailer; 2, Santa Rosa, Aug. 16, R. H. Beamer; 4, Santa Cruz Mts., Aug. 13, 1938, R. H. Beamer; 3, Santa Cruz Mts., Aug. 13, 1938, R. I. Sailer; 1, Lompoc, Aug. 7, 1938, R. I. Sailer; 1, Alpine, July 19, 1941, R. H. Beamer; 1, Arroyo Seco River, Aug. 8, 1938, R. H. Beamer; 1, Jacumba, July 17, 1940, R. H. Beamer; 1, Towie, Aug. 20, 1938, R. H. Beamer and 20, Boulevard, July 26, 1938, R. H. Beamer.

Host Plants: Ball (1932) writes "This California species was taken by the writer in number from *Rhus trilobata* in several places in the mountains around Prescott, Arizona." Ball was evidently referring to the subspecies *spicatus*, found in Arizona. Numerous specimens were collected in California in 1938 on *Arctostaphyleae* sp.

Comparative Notes: The dark face separates this species from *canus* and the truncate plates from *spicatus*. This species varies a great deal in color, although usually it is darker than the other two species mentioned above.

71. *Scaphytopius (Cloanthanus) trilineatus spicatus* Hepner

Scaphytopius (Cloanthanus) trilineatus subsp. *spicatus*, Hepner, L. W., Jour. Kan. Ent. Soc., XIX: p. 108, 1946.

Resembling *trilineatus* but lighter with fulvous areas of forewing restricted to apical cells and with plates sharply pointed. Length: female 5.5 mm., male 5 mm.

Color: Crown mottled ivory and fuscous with light markings as follows: thin line along anterior margin; long wedge; irregular arcuate vitta on each side of median suture from near apex to base and usually two pairs of large dots on posterior margin, one next each eye and another on each side of median suture. Pronotum

about same color as crown, lightest on anterior and lateral margins, vittae distinct. Scutellum ivory, dark irrorations and typical light markings. Face ivory with fine brown to fuscous irrorations excepting long sharksmouth and coarser irrorations along posterior margin, darkest on lateral margins of genae. Forewing semihyaline white except for small fulvous area in apical cells, fuscous vermiculations and veins throughout.

Structural Characteristics: Crown over twice as long as width between eyes in male, twice width between eyes in female, shallow concavity on disc, anterior margin straight to slightly concave on each side of pointed apex; wedge about half length of crown. Pronotum about half as long as crown, about two and one-fourth times as wide as length at middle and four times length behind eyes. Clypeus over two and one-half times as long as width at ocelli, concavity along sharksmouth, sinuate at antennae. Clypellus enlarged near apex. Face in lateral view concave between anterior margin of eyes. Forewing with several vein-like marks in brachial cell, about twelve recurved veins to costa and sometimes extra cross-veins in clavus.

Genitalia: Valve about one and one-half times as wide as length at middle, posterior margin rounded; anterior margin with broad, short, median lobe. Paraphyses with slight basal enlargement, slightly broadened just before sharp apices. Aedeagus in lateral view roughly "L"-shaped, short, almost parallel-margined throughout. Styles about two and one-half times as long as width at base, slightly sinuate just before middle, outer lobe on dorsal margin just before finger-like process on apical fifth.

Last ventral segment of female about one and one-half times as wide as length at middle, lateral margins converging; posterior margins with lobe on each side of relatively prominent median notch.

Types: Holotype ♂, allotype ♀, and 27 ♀ and 5 ♂ paratypes, Miami, Ariz., Aug. 6, 1941, R. H. Beamer, in the Snow Entomological Collections. Additional paratypes as follows: (Arizona) 1 ♀, Miami, July 22, 1932, R. H. Beamer; 7 ♀ ♀, 8 ♂ ♂, Yarnell, July 29, 1933, 4 ♀ ♀, 1 ♂, July 27, 1933, and 2 ♀ ♀, July 25, 1932, R. H. Beamer; 1 ♀, Yarnell Hts., July 2, 1929, R. H. Beamer; 1 pair, Yarnell, June 19, 1937, D. J. and J. N. Knull; 2 ♀ ♀, Yarnell Hts., June 21, 1935, 2 ♀ ♀, Oct. 8, 1929, 2 ♀ ♀, July 21, 1929, and 1 ♀, Aug. 20, 1929, E. D. Ball; 9 ♀ ♀, 6 ♂ ♂, Yarnell Hts., June 29, 1933, P. W. Oman; 1 pair Yavapai Co., July 1, 1929, and 1 ♀, Aug. 9, 1927, R. H. Beamer; 1 ♂, Granite Dell, Aug. 14, 1935, R. H.

Beamer; 1 ♀, Granite Dell, Oct. 6, 1929, and 4 ♀ ♀, July 17, 1929, E. D. Ball; 3 ♀ ♀, Prescott, July 29, 1933, R. H. Beamer; 1 ♀, Prescott, June 30, 1939, and 1 ♀, June 8, 1941, D. J. and J. N. Knull; 3 ♀ ♀, Prescott, N. F., July 6, 1937, 3 ♀ ♀, July 14, 1940, and 1 ♂, June 20, 1937, D. J. and J. N. Knull; 1 ♀, Santa Rita Mts., Aug. 18, 1935, R. H. Beamer; 1 ♀, Gila Co., Aug. 5, 1927, R. H. Beamer; 4 ♀ ♀, Hereford, Aug. 22, 1935, R. H. Beamer; 2 pairs, Huachucua Mts., July 20, 1937, D. J. and J. N. Knull; 2 ♀ ♀, Huachucua Mts., Oct. 19, 1931, E. D. Ball; 1 ♀, Oak Creek Canyon, July 13, 1940, D. J. and J. N. Knull; 1 ♀, Chiricahua Mts., Sept. 14, 1938, 1 ♀, June 15, 1939, and 1 ♂, Aug. 28, 1940, D. J. and J. N. Knull; 1 ♂, Devil's Canyon, Aug. 25, 1938, D. J. and J. N. Knull; 2 ♂ ♂, Faraway Ranch, Aug. 11, 1931, E. D. Ball; 1 ♀, Glenn Oaks, July 19, 1929, and 1 ♂, July 18, 1929, E. D. Ball. (New Mexico) 1 ♀, Silver City, Aug. 23, 1936, R. H. Beamer.

Host Plants: The specimen from Silver City was collected on Mountain Mahogany. Ball (1932) was evidently referring to this form when he gave *Rhus trilobata* as the host plant of *trilineatus*.

Comparative Notes: The males of this species can be separated from *trilineatus* by the sharp plates and the female by the absence of the notch on the last ventral segment.

72. *Scaphytopius (Cloanthanus) abbreviatus* (DeLong)

Platymetopius abbreviatus, DeLong, D. M., Tenn. St. Board of Entomology, XVII: p. 39, 1916.

Platymetopius parvus var. *niger*, DeLong, D. M., Ohio Jour. Sci., XLV: p. 27, 1945.

Color: Crown brown mottled with yellow, light markings as follows: thin line along anterior margin; wedge; indistinct arcuate line on disc on each side of median suture; typical large dots along posterior margin. Pronotum darker than crown, heavily irrorate, vittae visible. Scutellum about same color as crown, with typical markings. Face fulvous irrorate with brown, darkest on lateral margin of genae; sharksmouth, vitta behind eye and shorter ones near ocelli and at antennae, light. Forewings semihyaline fulvous with white aeroles and brown irrorations throughout; veins fuscous.

Structural Characteristics: Crown about one and one-half times as long as width between eyes, slightly concave on each side of bluntly pointed apex; wedge about one-third length of crown. Pronotum about three-fourths length of crown, two and one-third times as wide as length at middle and three and one-half times length behind eye. Clypeus about two and one-third times as

long as width at ocelli, only slightly constricted, if any, at antennae; shallow concavity along sharksmouth. Clypellus enlarged at apex. Face in lateral view definitely concave between anterior margin of eyes. Forewing with numerous vein-like marks in brachial cell, about nine recurved veins to costa and often extra cross-veins in clavus.

Genitalia: Valve about two-thirds as long as greatest width, posterior margin convex on each side of teat-like apex. Paraphyses long, slender and sharply pointed. Aedeagus in lateral view "L"-shaped, almost parallel-margined throughout. Styles almost five times as long as basal width, constricted on basal third, small lobe on outer margin before slender process on outer two-fifths.

Last ventral segment of female about two-thirds as long as greatest width, latero-posterior margin rounded.

Types: Lectotype ♀, Tullahoma, Tenn., Aug. 2, 1915, D. M. DeLong, here designated, in the DeLong Collection, Ohio State University, Columbus, Ohio. Allotype ♂, Tullahoma, Tenn., Aug. 3, 1915, D. M. DeLong, here designated, in the DeLong collection, Ohio State University, Columbus, Ohio. Additional ♂ paratypes as follows: (Florida) 13, Sanford, July 25, 1934, R. H. Beamer; 3, Sanford, Aug. 8, 1939, R. H. Beamer; 1, Sanford, Aug. 8, 1939, A. T. Hardy; 3, Pensacola, July 12, 1934, R. H. Beamer; 1, Yankeetown, July 17, 1934, R. H. Beamer; 3, Lacoochee, Aug. 18, 1930, R. H. Beamer; 1, Branford, July 16, 1934, R. H. Beamer; 2, Branford, July 31, 1930, P. W. Oman; 1, Homestead, Aug. 9, 1930, R. H. Beamer; 1, Ft. Myers, Aug. 14, 1930, R. H. Beamer; 3, July 16, 1939, La Belle, R. H. Beamer; 1, July 16, 1939, La Belle, P. B. Lawson; 4, Suwanee Spgs., Aug. 2-3, 1939, R. H. Beamer; 1, Likely, July 24, 1934, R. H. Beamer; 1, Wildwood, Aug. 2, 1930, R. H. Beamer; 1, Hilliard, Aug. 6, 1939, R. H. Beamer and 1, Dunnellon, July 12, 1939, R. H. Beamer. (Georgia) 3, Griffin, Aug. 12, 1939, R. H. Beamer; 2, Okefenokee Swamp, Aug. 3, 1934, R. H. Beamer and 1, Folkston, Aug. 2, 1934, R. H. Beamer. (Alabama) 1, Burnsville, July 20, 1930, P. W. Oman; 2, Marion Jct., July 16, 1930, L. D. Tuthill; 2, Prattville, July 21, 1930, R. H. Beamer; 1, Tuskegee, July 22, 1930, P. W. Oman and 1, Montgomery, July 1, 1939, R. H. Beamer. (Mississippi) 2, Shuqualak, July 16, 1930, R. H. Beamer; 1, Fulton, July 14, 1930, L. D. Tuthill; 2, Fulton, July 14, 1930, R. H. Beamer; 4, Columbus, July 16, 1930, R. H. Beamer; 1, Columbus, July 16, 1930, P. W. Oman; 1, Columbus,

July 16, 1930, L. D. Tuthill and 2, Hamilton, July 15, 1930, L. D. Tuthill. (Louisiana) 5, Nachitoches Parish, Aug. 16, 1928, R. H. Beamer; 1, Caddo Parish, Aug. 19, 1928, L. D. Beamer and 1, Beauregard Parish, Aug. 16, 1928, E. I. Beamer. (Tennessee) 3, Clarksville, Oct. 8, 1914.

Host Plants: Ball (1932) writes "The writer found it fairly common on *Ceanothus americanus* at Sanford, Florida."

Comparative Notes: This is one of the commonest species found in the Southeast. The entire face is marked, but the clypeus is lighter than the margins of the genae, separating it from *triangularis*, and it is much darker than *cinereus*. It may be found as far north as New Jersey. The genitalia are variable but the long, slender paraphyses, "L"-shaped aedeagus and long process on style readily separate it from any other. The frons of the Florida species are much lighter than those from further north.

73. *Scaphytopius (Cloanthanus) triangularis* DeLong

Cloanthanus triangularis, DeLong, D. M., Ohio Jour. Sci., XLV: p. 27, 1945.

Resembles *acutus* but with dark face and paraphyses enlarged near apex. Length: female 4.8 mm., male 4.2 mm.

Color: Crown mottled brown and light, often darkest on disc, with light markings as follows: thin line along anterior margin; wedge; irregular vittae on disc, either straight or arcuate; irregular area before eyes; typical light spots along posterior margin. Pronotum slightly lighter than crown, heavily irrorate with dark, vittae usually visible. Scutellum lighter than pronotum with typical markings. Face fulvous irrorate with dark, excepting wedge, vitta behind eye and shorter ones near ocelli and antennae. Forewing semihyaline fulvous with light aeroles and fuscous vermiculations throughout; veins brown, becoming fuscous on apex and costal margin.

Structural Characteristics: Crown about twice as long as width between eyes, anterior margin straight on each side of pointed apex; wedge about half length of crown. Pronotum three-fifths as long as crown, two and one-third times as wide as length at middle and three and one-half times length behind eyes. Clypeus over twice as long as width at ocelli, shallow concavity along sharksmouth, only slightly sinuate at antennae. Clypellus only slightly enlarged near apex. Face in lateral view concave between anterior margin of eyes. Forewing with vein-like marks in brachial cell, about ten recurved veins to costa and sometimes extra cross-veins in clavus.

Genitalia: Valve about one and two-fifths as wide as length at middle, posterior margin rounded; anterior margin with short, broad, median lobe. Paraphyses with slight enlargement at base, and somewhat enlarged just before sharp apices. Aedeagus in lateral view slightly curved, largest just before middle, bluntly pointed. Styles almost three times as long as basal width, sinuate near basal third, lobe on dorsal margin before slightly curved, finger-like process on apical third.

Last ventral segment of female with lateral margins short, posterior margin almost straight on each side of blunt apex.

Types: Types in Illinois Natural History Survey collection, Urbana, Illinois. One ♂ paratype was on hand for study.

Additional Material Studied: (Kansas) Douglas Co. and Leavenworth Co. (Illinois) Union Co. (Indiana) Gary and Tippecanoe Co. (Tennessee) Clarksville. (Maryland) Annapolis. (South Carolina) Charleston. (Mississippi) Meridian, Lincoln Co. and Tishomingo Co. (Alabama) Prattsville, Etowah Co. and Tuskegee. (Florida) La Belle and Ft. Mead.

Host Plants: The original description gave *Crataegus* sp. as the host. Specimens from Etowah Co., Ala., were labeled as from *Prunus angustifolia* and the author has collected the species in Kansas from rose.

Comparative Notes: The dark brown face separates this species from most, since it has a shorter, broader crown than *rubellus*.

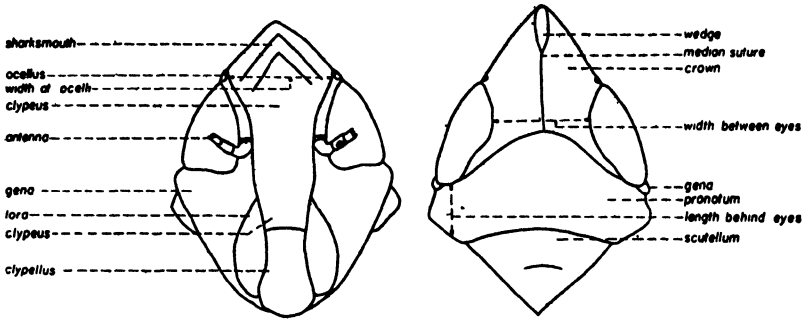
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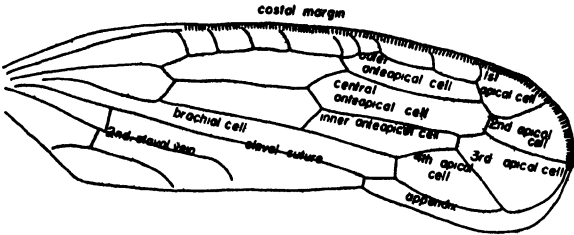
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- , 1925. New Hemiptera from western North America. Proc. Calif. Acad. Sci., vol. 14, pp. 391-425.
- WEISS, H. B. 1917. Additions to insects of New Jersey. Ent. News, vol. 28, pp. 214-221.
- YOUNG, D. B. 1910. Additional list of Adirondack insects. Bull. N. Y. State Museum No. 141, pp. 123-125.

PLATE XXIII

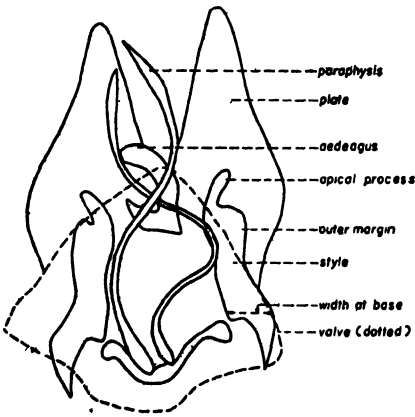


VENTRAL VIEW- HEAD

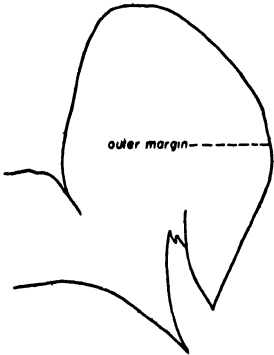
DORSAL VIEW- HEAD, PRONOTUM and SCUTELLUM



FOREWING



GENITALIA- VENTRAL VIEW

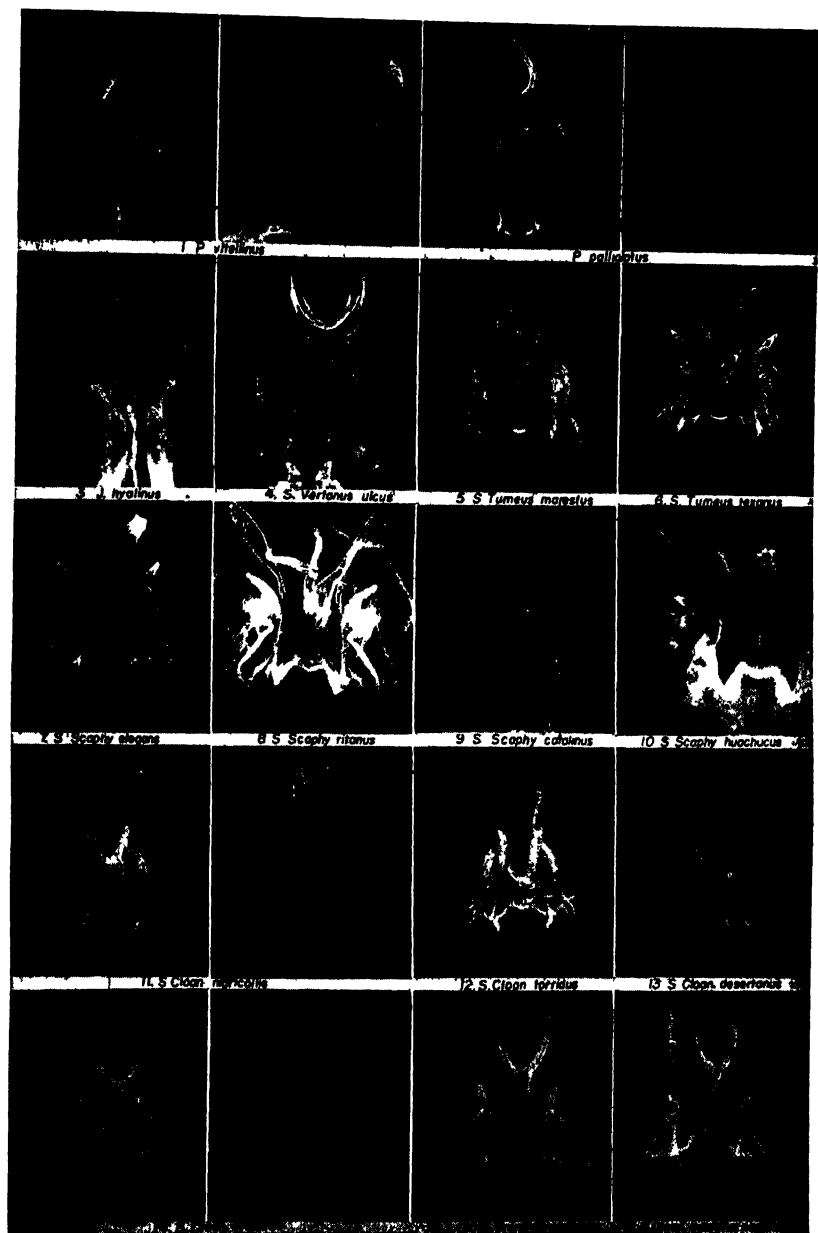


PYGOFER

SCAPHYTOPIUS (CLOANTHANUS) ANGUSTATUS (OSBORN)

Scaphytopius (Cloanthanus) angustatus (Osborn)

PLATE XXIV



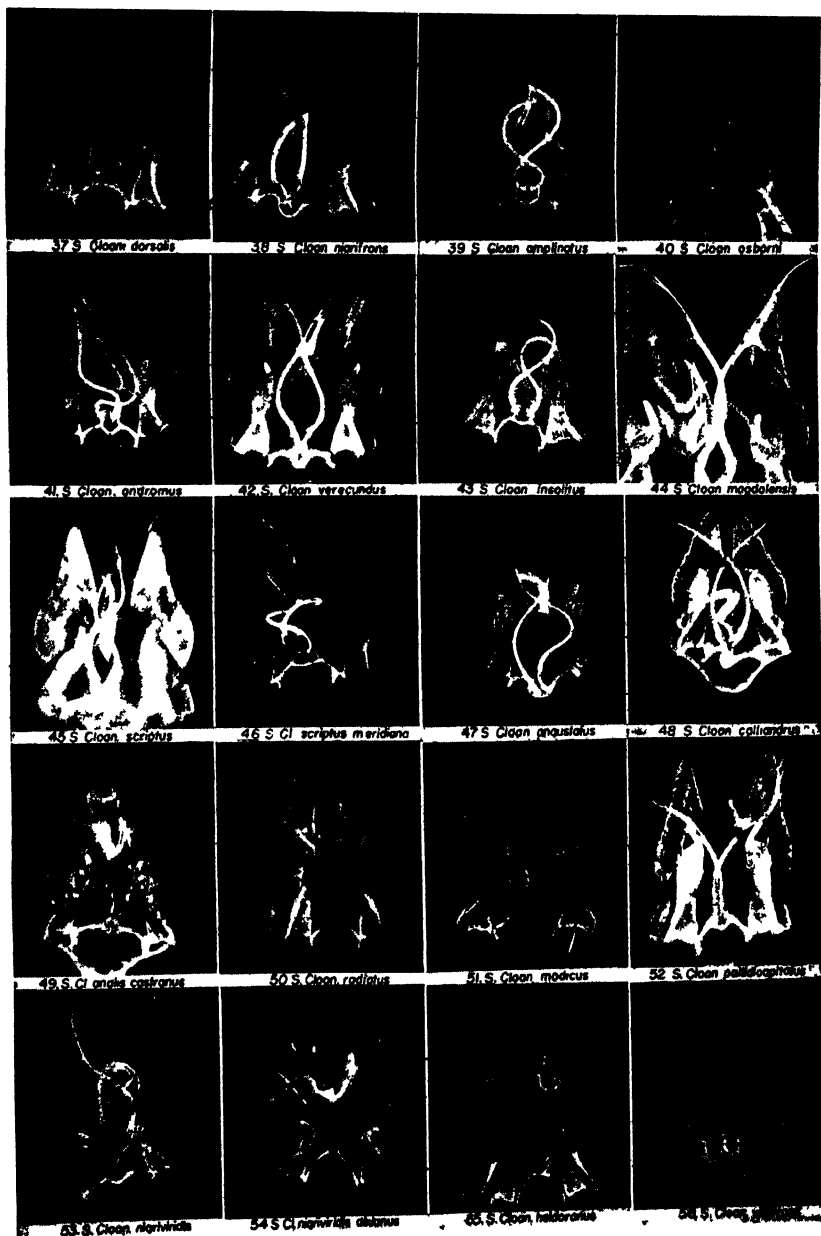
Male genitalia of the Scaphytopini

PLATE XXV



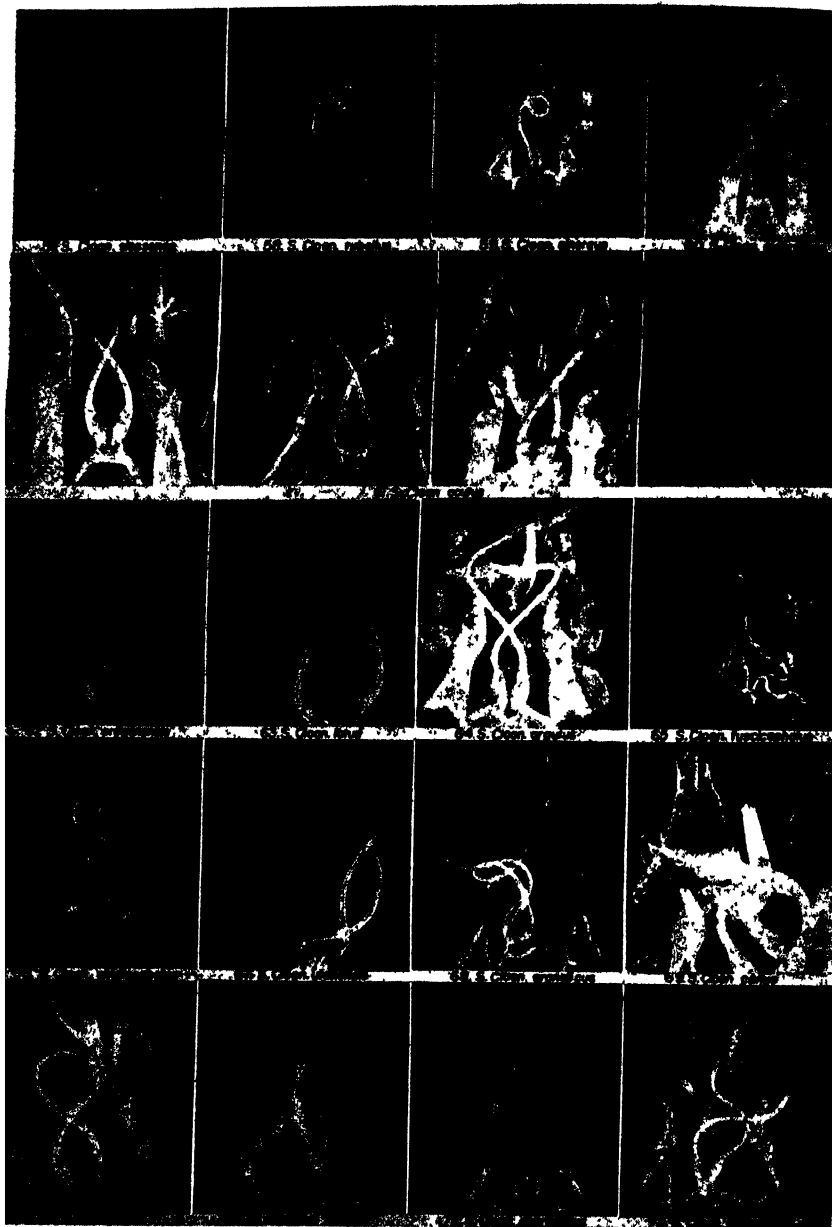
Male genitalia of the Scaphytopini

PLATE XXVI



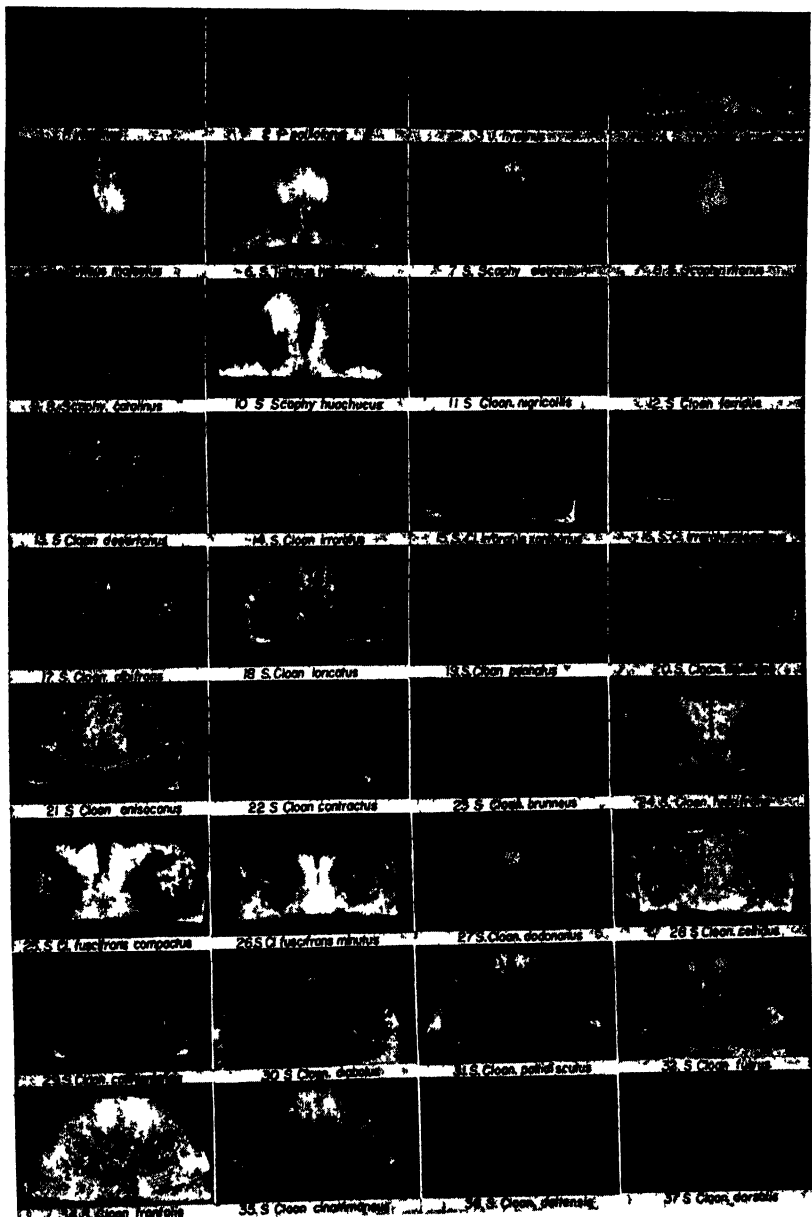
Male genitalia of the Scaphytopini

PLATE XXVII



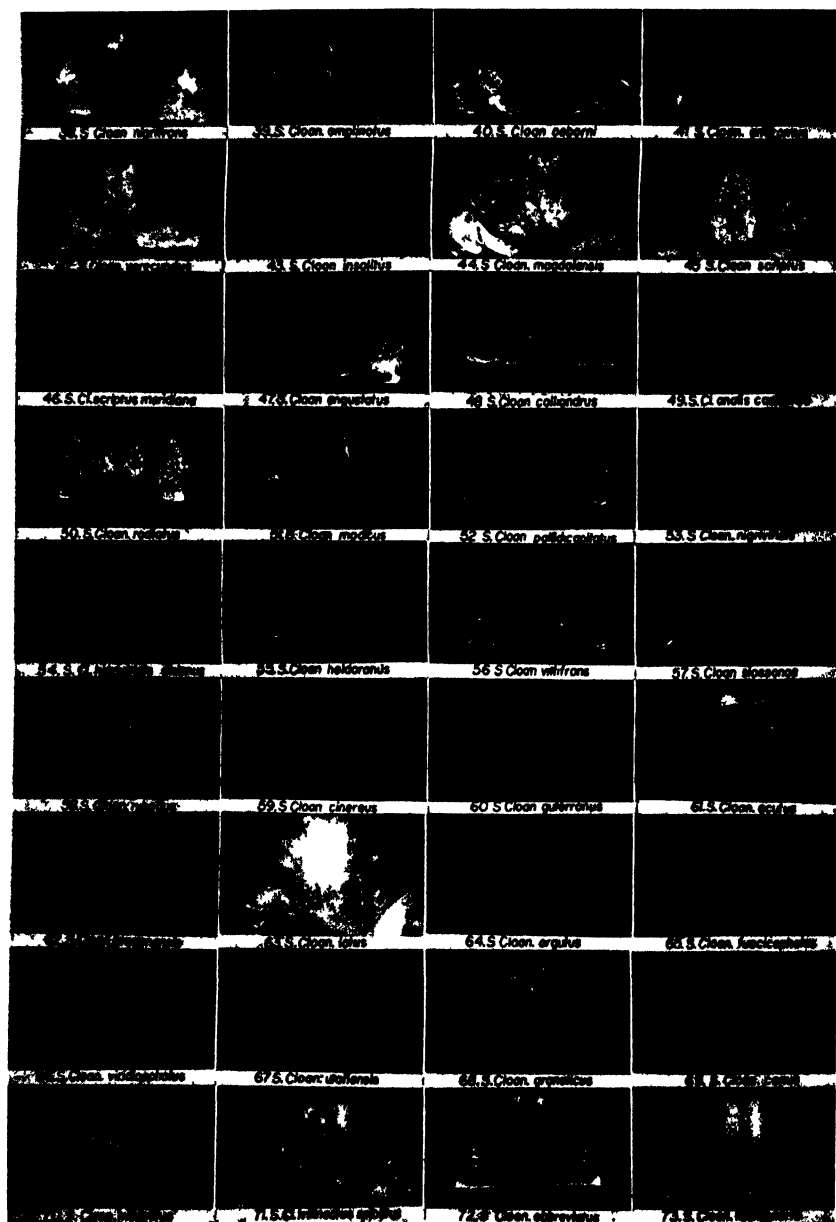
Male genitalia of the Scaphytopini.

PLATE XXVIII



Female genitalia of the Scaphytopini

PLATE XXIX



Female genitalia of the Scaphytopini

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[No. 17]

A Bibliography of Mexican Amphibiology

By EDWARD H. TAYLOR

NO COMPREHENSIVE bibliography dealing with the amphibiology of Mexico has ever been published. The present wide interest in this subject practically demands that such a publication be made available to the numerous workers in this new field. For the past 15 years during my extensive work on Mexican faunas I have been collecting literature dealing with this particular subject, and the following annotated list of titles dealing with the amphibiology of Mexico is offered to fill this need. It is as complete as I have been able to make it for taxonomic works, but I feel that further research might reveal other titles of significance dealing with anatomy and physiology of Mexican species.

It is possible that some of the titles listed, purporting to treat of the "Mexican axolotl," may actually not do so. However, in most cases the authors believed that the European bred stock of the *axolotl* was from species originating in Mexico. Certain of these papers have not been read by me.

About fifty of the titles were added by Dr. Hobart M. Smith who had the kindness to read the manuscript and check the reference. He has my heartfelt gratitude.

ACKERMANN, J.

1933. Ueber die Innervierung der Haut des Axolotls (*Ambystoma mexicanum*). Bull. Acad. Polonaise Sci. (Sect. B), 1933, No. 2, pp. 1-12, pl. 1.

AHL, ERNST.

- 1927 Ueber neue oder seltene Froschlurche aus dem Zoologischen Museum Berlin. Sitz. Ges. nat. Freunde, 1926 (May 1, 1927), pp. 111-117.
Type description of *Bufo eiteli*.
1932. Neu oder selten eingeführte Fische, Lurche und Kreichtiere. Das Aquarium, Jan., 1932, pp. 1-4, ill.
Rhinophrynus dorsalis discussed and figured.
1934. Ueber eine Sammlung von Reptilien und Amphibien aus Mexiko. Zool. Anz., 106, No. 7-8, Apr. 15, 1934, pp. 184-186, text fig. 1.
Type description of *Hyla leonhard-schultzei* and notes on other species.

ALLEN, MORROW J.

1933. Report on a collection of amphibians and reptiles from Sonora, México with the description of a new lizard. Occ. Papers Mus. Zool., Univ. Michigan, No. 259, Apr. 3, 1933, pp. 1-15.

Lists *Scaphiopus couchii*, *Bufo alvarius*, *Pternohyla fodiens*, *Gastrophryne texensis*.

ANONYMOUS.

1865. Reproduction of the Axolotl. Nat. Hist. Rev., 1865, pp. 454-455.
1866. Nyere Jagttagelser om Axolotlen (Med traesnit.) Tidsskr. pop. Fremstilling af Naturvidensk, 3 R., 3, 1866, pp. 325-330.
1870. Kunstliche Bildung einer weissen Rasse u Metamorphose des Axolotl. (auszug.) Naturforscher (Sklarek), 3, 1870, p. 196. (*Fide* Duméril, in Compt. Rend., 70, 1870, p. 782.)
- 1876a. Az Axolotl atvaltozasarol amblystomava. Term. Tud. Közl. 8 Köt, 1876, pp. 439-440 (See Weismann. Zeit. Wiss. Zoll. 25, Suppl.)
- 1876b. Fortpflanzung des Amblystoma (übersetzung). Naturforscher (Sklarek). 9, 1876, pp. 215-216. (See Blanchard, in Compt. Rend., 82, 1876, p. 716.)
- 1876c. Eine neue Deutung des Axolotl (auszug). Naturforscher (Sklarek), 9, 1876, pp. 114-115.
1877. Reproduction des Axolotls transformées en Amblystomes. Journ. Zool. (Gervais), 6, 1877, pp. 152-153.
1879. Zur Metamorphose des Axolotl. Gäa., 15, 1879, pp. 186-187.

ATKINSON, D. A.

1907. Notes on a collection of batrachians and reptiles from Central America. Ohio Naturalist, 7, May 1907, pp. 151-157.

Hyla taeniopus listed from Morales, Guatemala. Probably erroneously identified.

BAIRD, SPENCER F.

1849. Revision of the North American tailed-batrachia, with descriptions of new genera and species. Journ. Acad. Nat. Sci. Philadelphia, (2), 1, 1849, pp. 281-294.

Type description of *Amblystoma mavortia*.

1854. Descriptions of new genera and species of North American frogs. Proc. Acad. Nat. Sci. Philadelphia, 7, 1854-1855 (April, 1854), pp. 59-62.

Contains the type descriptions of *Hyla eximia*, *Hyla vanvlietii*, *Hyla affinis*, *Rana montezumae*, and *Scaphiopus couchii*.

1859. Reptiles of the boundary. (In) United States and Mexican boundary survey under the order of Lieut. Col. W. H. Emory, 1859, 2, Reptiles, pp. 1-35, pls. 1-41.

The "type description" of *Batrachyla longipes* consists of 1-3 on plate 37. *Bufo alvarius* is described by Girard from the "Valley of the Gila and Colorado."

BAIRD, SPENCER F., and GIRARD, CHARLES.

1852. Characteristics of some new reptiles in the museum of the Smithsonian Institution. Proc. Acad. Nat. Sci. Philadelphia, 6, 1852-1853 (Oct., 1852), p. 173.

Type descriptions of *Amblystoma proserpine*, *Bufo punctatus*, *Rana areolata*, and *Bufo granulatus*, all from Texas.

BARBOUR, THOMAS.

1922. Three new neotropical Salientia. Proc. Biol. Soc. Washington, 35, Oct. 17, 1922, pp. 111-114.

Eleutherodactylus dunnii and *Syrhopus* (sic) *mystaceus* are described.

1923. The reappearance of *Batrachyla longipes*. Proc. New England Zool. Club, 8, June 5, 1923, pp. 81-83.

Reports a specimen of *Eleutherodactylus* (sic) *longipes* (= *Eleutherodactylus batrachylus* Taylor).

1926. Reptiles and amphibians. Houghton Mifflin Company, Boston and New York, 1926, pp. xxii + 126.

The axolotl figured, p. 99.

1927. *Cauphias* rediscovered. Copeia 1927, No. 165, pp. 96-98.

BARBOUR, THOMAS, and COLE, LEON J.

1906. Reptilia, Amphibia, and Pisces. (In) Vertebrata from Yucatán. Bull. Mus. Comp. Zool., 50, No. 5 (part.), 1906-1907 (Nov. 1906), pp. 146-155.

The following specimens are reported: *Rana virescens areolata*, *Bufo valliceps*, *Bufo marinus*, *Hyla phlebodes*, *Hyla baudini*, *Triprion petasatus* and *Spelerpes yucatanus*.

BARBOUR, THOMAS, and LOVERIDGE, ARTHUR.

1929. Typical reptiles and amphibians. Bull. Mus. Comp. Zool., 69, No. 10, June 1929, pp. 205-360.

Lists a few specimens from México.

BARNES, D. H.

1826. An arrangement of the genera of batracian animals, with a description of the more remarkable species. Amer. Journ. Sci. Arts (Sillimans Journal), (1), 11, Oct. 1826, pp. 268-297.

Proteus mexicanus is discussed and its synonyms given.

BEDRIAGA, JACQUES V.

1877. Bemerkungen über die Umwandlung des Axolotl in ein Amblystoma. Zool. Garten, 18, 1877, pp. 132-133.

BELDING, L.

- 1887a. Collecting in the cape region of Lower California. The West American Scientist, 3, No. 24, Apr. 1887, pp. 93-97.

Mentions discovery of a new toad (*Bufo beldingi*).

- 1887b. Reptiles of the cape region of Lower California. *Ibid*, pp. 97-99.

List of five amphibians.

BELTRAN, ENRIQUE.

1941. Opalinidos parasitos en anfibios Mexicanos. Rev. Soc. Mex. Historia Natural, 2 (2 & 3), pp. 127-136, pl. 3.

BERT, PAUL.

1869. Ablation chez au Axolotl des branchies et des poumons. Compt. Rend. et Mém. Soc. Biol. Paris, (4) 5, 1868 (1869), C. R. pp. 21-22.

1880. (Influence des lésions du cerveau sur les appareils de coloration des axolotls). Compt. Rend. et Mém. Soc. Biol. Paris, (7), 1, 1879 (1880), C. R. p. 65.

BINNEWALD, CARL A. E.

1914. Das Vorderhirn von *Ambystoma mexicanum*. Arch für Mikr. Anat., 84, Abt. 1, pp. 1-74, 1 pl., text figs. A-B.

BLANCHARD, EMILE.

- 1876a. Reproduction of *Amblystoma*. Ann. Mag. Nat. Hist., (4), 17, 1876, pp. 414-415.
 1876b. Reproduction de l'*Amblystome*, observée au Muséum. Compt. Rend., 82, 1876, pp. 716-717.
 1879. Sur la ponte des *Amblystomes* au Muséum d'histoire naturelle. (Extr.) Rev. des Sciences, 4, 1879, p. 167.

BLANCHARD, RAPHAEL.

- 1882a. (Review of Velasco's study on the habits of the ajolote.) Rev. Sci., May 13, 1882, pp.
 1882b. (Review of Velasco's study.) La Nature, 6, 1882, pp. 60-61.
 A translation of the preceding article.

BLATCHLEY, W. S.

1893. On a collection of batrachians and reptiles from Mount Orizaba, Mexico, with descriptions of two new species. Proc. U. S. Nat. Museum, 16, No. 922, 1893, pp. 37-42.
 Type descriptions of *Spelerpes orizabensis* and *Spelerpes gibbicaudus* appear. Also records *Spelerpes bellii* (= *B. gadovii* Dunn), *Bufo intermedius*, *Hyla eximia* and *Hyla miotypanum*.

BLUM.

1880. Der mexikanische Kiemenmolch oder Axolotl (*Ambystoma mexicanum* Cope (*tigrinum*), seine Züchtung u. Pflege. Isis (Russian), 5, 1880, pp. 59-61, 67-68, 75-77.

BOETTGER, OSCAR.

1892. Katalog der Batrachier-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main. Frankfurt, 1892, pp. x + 73.
 Numerous Mexican species listed.
 1893. Ein neuer Laubfrosch aus Costa Rica. Bericht. Senck. Natur. Ges., 1892-1893 (1893), pp. 251-252.
Hyella fleischmanni described from San José, Costa Rica.

BOGDANOFF, N.

1873. (On the transformation of the axolotl) (In Russian) Trud. C. Peterb. ectect. 4, 1873, pp. lxxxiii-lxxxiv.

BOGERT, CHARLES M., and OLIVER, JAMES A.

1945. A preliminary analysis of the herpetofauna of Sonora. Bull. Amer. Mus. Nat. Hist., 83, (6), pp. 297-426, figs. 1-13, pls. 30-37, table 1, maps 1, 2.

BOULENGER, EDWARD G.

1913. Experiments on the metamorphosis of the Mexican axolotl (*Ambystoma tigrinum*), conducted in the society's garden. Proc. Zool. Soc. London, No. 28, May 20, 1913, pp. 403-412, text figs. 75-76.

BOULENGER, GEORGE ALBERT.

1881. *Leptodactylus caliginosus* Girard et L. *albilabris* Günther. Bull. Soc. Zool. France, 6, 1881, pp. 30-35.

- 1882a. Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd Ed., 1882, pp. xvi + 503, pls. 1-30.
Treats of the known fauna of this group, in México.
- 1882b. Catalogue of the Batrachia Gradients s. Caudata and Batrachia Apoda in the collection of the British Museum. 2nd Ed., 1882, pp. viii + 127, pls. 1-9.
- 1882c. Description of a new genus and species of frogs of the family *Hylidae*. Ann. Mag. Nat. Hist., (5), 10, No. 58, Oct. 1882, pp. 326-328.
Genus *Pternohyla*, and *Pternohyla fodiens* are described. *Hyla venulosa* and *Hyla dacnicolor* are discussed.
- 1883a. Descriptions of new species of lizards and frogs collected by Herr A. Forrer in Mexico. Ann. Mag. Nat. Hist., (5), 11, 1883, pp. 342-344.
The following type descriptions are given: *Rana forreri*, *Rana pustulosa* and *Hypopachus oxyrrhinus*.
- 1883b. Notes on little-known species of frogs. Ann. Mag. Nat. Hist. (5), 11, 1883, pp. 17-20.
- 1883c. Reptilia and Batrachia. Zoological Record, 19, 1882, pp. 1-28.
States that *Speleperpes yucatanus* Peters and *Speleperpes yucatanicus* Boulenger are identical. "Peters' description appears to have a few days priority over the Recorder's," p. 26.
1884. Reptilia and Batrachia. Zoological Record, 20, 1883, pp. 1-24.
Refers *Bufo beldingi* to *Bufo punctatus*.
1887. Descriptions of new reptiles and batrachians in the British Museum (Nat. Hist.), Part III. Ann. Mag. Nat. Hist., (5), 20, No. 115, July 1887, pp. 50-53.
Describes *Hyla copii* from El Paso, Texas, on the Mexican border.
- 1888a. On a rare American newt, *Molge meridionalis* Cope. Ann. Mag. Nat. Hist., (6), 1, No. 1, Jan. 1888, p. 24.
- 1888b. Note on the classification of the Ranidae. Proc. Zool. Soc. London, pt. 2, Feb. 10, 1888, pp. 204-206.
Discusses the genus *Syrhropus* (sic), placing *Malachylodes* Cope and *Hypodictyon* Cope in synonymy.
- 1888c. Descriptions of new Brazilian batrachians. Ann. Mag. Nat. Hist., (6), 1, No. 3, Mar. 1888, pp. 187-189.
Discusses the genus *Eupemphix* (= *Engystomops* [part.]), and refers the genus to the Bufonidae.
1891. Notes on American batrachians. Ann. Mag. Nat. Hist., (6), 8, No. 48, Dec. 1891, pp. 453-458.
Hylella sumichrasti. Notes that *Eserodonta Sumichrasti* Brocchi and *Hylella platycephala* Cope are synonyms, and that Brocchi's name is oldest.
- 1895a. A synopsis of the genera and species of apodal batrachians with description of a new genus and species *Bdellophis vittatus*. Proc. Zool. Soc. London, 1895, pp. 410-414, pls. 23-24.
- 1895b. Reptilia and Batrachia. Zoological Record, 31, 1894, pp. 1-44.
Regards *Hylella chrysops* Cope as a synonym of *Hylella feischmanni* Boettger.
1898. Fourth report on additions to the batrachian collection of the Natural History Museum. Proc. Zool. Soc. London, June 7, 1898, pp. 473-482, pls. 38-39.
Type descriptions of *Hylodes alfredi* and *Borborocastes mexicanus*. Figures of both are given.

1899. Descriptions of new batrachians in the collection of the British Museum (Natural History). *Ann. Mag. Nat. Hist.*, (7), 3, 1899, pp. 273-277, pls. 11, 12.

Proposes *Hyla underwoodi* nom. nov. for *Hyla microcephala* Boulenger (nec Cope).

1902. Reptilia and Batrachia. *Zoological Record*, 38, 1901, pp. 1-33.

Proposes *Hyla smithi* nom. nov. for *Hyla nana* Günther (nec *Hyla nana* Boulenger).

1903. Descriptions of new batrachians in the British Museum. *Ann. Mag. Nat. Hist.*, (7), 12, No. 71, Nov. 1903, pp. 552-557.

Type descriptions of *Eupemphiz gadovii* and *Hylodes beatus* appear.

1910. Axolotl. *In Encycl. Brit.*, Ed. 11, 3, pp. 68-70.

Excellent historical discussion, with bibliography (not in later editions).

1917. Descriptions of new frogs of the genus *Rana*. *Ann. Mag. Nat. Hist.*, (8), 20, No. 120, Dec. 1917, pp. 413-418.

Describes *Rana tarahumarae* from Iquiro and Barranca del Cobre, Sierra Tarahumara, N. W. México.

1919. Synopsis of the American species of *Rana*. *Ann. Mag. Nat. Hist.*, (9), 3, No. 16, Apr. 1919, pp. 408-419.

Rana montesumae, *Rana tarahumarae*, *Rana halecina* (includes *Rana forsteri*), *Rana pustulosa*, *Rana palmipes*. He discusses Peters' genus *Ranula*.

1920. A monograph of the American frogs of the genus *Rana*. *Proc. Amer. Acad. Arts Sci.*, 55, No. 9, Aug. 1920, pp. 413-480.

Mexican forms treated here are: *Rana montesumae*, *Rana halecina*, *Rana draytonii*, *Rana tarahumarae*, *Rana pustulosa*, and *Rana palmipes*.

BRAGG, ARTHUR N.

1941. Tadpoles of *Scaphiopus bombifrons* and *Scaphiopus hammondi*. *The Wassmann Collector*, 4, No. 3, Apr. 1941, pp. 92-94.

BRAVO H., MARGARITA.

- 1943a. Dos nuevos nematodos parásitos de anuros del sur de Puebla. *Anal. Inst. Biol.*, 14, (1), pp. 69-78, pls. 1-3.

- 1943b. Estudio sistematico de los trematodos parásitos de los "ajolates" de México. *Anal. Inst. Biol.*, 14, (1), pp. 141-159, pls. 1-5.

BRAVO, H., MARGARITA, and CABALLERO C., EDUARDO.

1940. Nematodos parásitos de los batracios de México. IV. *Anal. Inst. Biol. México*, 11, pp. 239-247, pls. 1-3.

Bufo marinus and *Rhyacosiredon altamirani* studied.

BROCCHI, PAUL.

- 1877a. Sur le système nerveux de l'axolotl (*Siredon mexicanus*). *Bull. Soc. Philom. Paris*, (7), 1, 1876-1877 (1877), pp. 21-24.

- 1877b. Note sur les nerfs trijumeau et facial de l'axolotl. *Bull. Soc. Philom. Paris*, (7), 1, 1876-1877 (1877), pp. 59-61.

- 1877c. De l'absence du grand sympathique chez l'axolotl. *Bull. Soc. Philom. Paris*, (7), 1, 1876-1877 (1877), pp. 71-73.

- 1877d. Description d'un nouveau genre de Phaneroglosse Hylaeforme (*Plectrohyla guatemalensis*). *Bull. Soc. Philom. Paris*, (7), 1, No. 2, 1876-1877 (1877), pp. 92-93.

Genus *Plectrohyla* described.

- 1877e. Note sur quelques batraciens hylaeiformes recueillis au Mexique et au Guatemala. Bull. Soc. Philom. Paris, (7), 1, No. 3, 1876-1877 (1877), pp. 122-132.

Hyla plicata, the genus *Cauphas*, and *Cauphas crassus* are described as new. *Hyla baudinii* and *Hyla eximia* are discussed.

- 1877f. Sur quelques Batraciens Raniformes et Bufoniformes de l'Amérique Centrale. Bull. Soc. Philom. Paris, 1876-1877 (1877), (7), 1, No. 4, pp. 175-197.

The following Mexican species are described: *Cystignathus fragilis*, *Leuiperus* (sic) *mexicanus*, *Bufo levifrons*, *Rhinophrynus rostratus*. The *Rana maculata* from "Totoncapam, Mexique" is probably from Guatemala.

1879. Sur divers Batraciens anoures de l'Amérique Centrale. Bull. Soc. Philom. Paris, (7), 3, No. 1, 1878-1879 (1879), pp. 19-24.

The type description of the following species appear: *Ezerodonta sumichrasti*, *Hyla paenulata* (from Guatemala), *Hylodes Augusti* Dugès, *Hylodes lineatus* ("Attitlan Mexique" but probably from Guatemala), *Scaphiopus dugesii* and *Bufo mexicanus*.

1881 to

1883. études des batraciens de l'Amérique Centrale (In) Mission Scientifique au Mexique et dans l'Amérique Centrale, Part 3, Sec. 2, 1881-1883, pp. 1-122, pls. 1-21. Issued as follows: Livr. 1, 1881, pp. 1-56, pls. 1-5, 9, 10. Livr. 2, 1882, pp. 57-96, pls. 6-8, 11-15. Livr. 3, 1883, pp. 97-122, pls. 7, 12, 16, 17, 17bis, 18, 18bis, 19, 20, 20bis, 21.

The following Mexican species are described as new: *Spelerpes laticeps*, *Spelerpes sulcatum* and *Spelerpes punctatum*. (The descriptions of *Hylodes lineatus* and *Ezerodonta sumichrasti*, said to be the original, are not.)

BROWN, ARTHUR ERWIN.

1906. Generic types of Nearctic reptilia and amphibia. Phila. Acad. Nat. Sci., Proc. 1906, 59, pp. 112-127.

BURT, CHARLES W.

1932. Some Mexican herpetological records. Copeia, 1932, No. 3, Oct. 7, p. 158.

BUSNEL, R.-G., and DRILHON, A.

1942. Influence de la pigmentation mélanique sur l'intensité de la respiration cutanée d'un Vertébré inférieur, *Axolotl mexicanum* Shaw. C. R. Acad. Sci. Paris, 214 (5), pp. 238-241.

CABALLERO Y C., EDUARDO.

1933. Nematodos parásitos de los batracios de México. Anal. Inst. Biol. Mex., 4, No. 3 and 4, 1933, pp. 187-190, figs. 1-6.

Dermophis mexicanus.

1938. Revisión y clave de las especies del género *Glypthelms*. Anal. Inst. Biol. Mex., 9, 1938, pp. 121-149, figs. 1-11.

Rana montesumae.

1940. Nuevos genero y especie de Hirudineo perteneciente a la subfamilia HAEMADIPSINAE. Anal. Inst. Biol. Mex., 11, No. 2, 1940, pp. 573-583, fig. 1-7.

Rhyacoredon altamirani, *Oedipus*.

- 1942a. Tremátodos de las Ranas de la Ciénaga de Lerma, México. 1. Anal. Inst. Biol. Mex., 12, No. 2, 1942, pp. 623-641, figs. 1-6.

Rana montesumae and *Rana pipiens*.

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COLE, C. E.

1928. Notes on the breeding of the Mexican axolotl. S. Aus. Nat. 9, (4), pp. 63-65.

COPE, EDWARD DRINKER.

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Discusses *Spelerpes bellii* and *Geotriton carbonarius*.

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Describes *Hyla muricolor* from Mirador, Veracruz, *Hyla callidryas* from Panamá, and *Hyla phaeota* from Turbo, Darien. He proposes the genus *Scytotis* and considers the recent breaking up of the genus *Bufo* and refers Mexican species to the following genera: *Chilophryne cognata*, *Phrynoidis alvarius*, *Bufo simus*, *Bufo anomalus*, *Bufo insidiator* and *Bufo punctatus*.

1863. On Trachycephalus, Scaphiopus and other American Batrachia. Proc. Acad. Nat. Sci. Philadelphia, 15, 1862 (1863) pp. 43-54.

Type descriptions of *Hyla miotympanum*, *Scaphiopus multiplicatus*, *S. varius*, and *S. rectifrenus*. Also lists *Hyla griseus* (Mexico?), *Hyla baudinii*, *Scaphiopus couchii*. Places *Spelerpes chiropterus* under AMBLYSTOMIDÆ.

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Original description of *Phyllomedusa dacnicolor* from near Colima. *Pseudocochranella pustulosus* from River Truando in New Granada. *Agalychnis callidryas* and *A. moreletii* are mentioned.

- 1864b. On the limits and relations of the Raniformes. Proc. Acad. Nat. Sci. Philadelphia, 16, 1864, pp. 181-183.

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- 1865a. Sketch of the primary groups of Batrachia s. Salientia. Nat. Hist. Rev., 1865, pp. 97-120.

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- 1865b. Third contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 17, Oct. 1865, pp. 185-198.

Describes *Pharyngodon petasatus*, *Hyla gracilipes*, *Hyla staufferi*, *Smilisca daulinia*, *Spelerpes orculus*, *Spelerpes cephalicus*, *Spelerpes lineolus*.

- 1866a. On the structures and distribution of the genera of the arciferous Anura. Journ. Acad. Nat. Sci. Philadelphia, (2), 6, pt. 1, July 1866, pp. 67-112, pl. 25.

- 1866b. Fourth contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 18, 1866, pp. 123-132.

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- 1867a. On the reptilia and batrachia of the Sonoran province of the Nearctic Region. Proc. Acad. Nat. Sci. Philadelphia, 18, 1866, pp. 300-314.

Type descriptions of *Hyla curta* and *Bufo frontoens*. Lists also *Hyla regilla*, *Scaphiopus couchii*, *Bufo punctatus*, from the cape region of Baja California.

- 1867b. Fifth contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 18, 1866, pp. 317-323.

The type description of *Lithodytes rhodopis*, said to be near *L. griseus* of the same region (Orizaba).

- 1867c. On the families of the raniform Anura. Journ. Acad. Nat. Sci. Philadelphia, (2) 6, Part II, Art. 4, Sept. 1867, pp. 180-205.

Systoma ustum mentioned.

- 1868a. A review of the species of the Amblystomidae. Proc. Acad. Nat. Sci. Philadelphia, 19, 1867, pp. 166-211.

Amblystoma mexicanum and *Amblystoma mavortium* var. *proserpine* are discussed.

- 1868b. An examination of the Reptilia and Batrachia obtained by the Orton expedition to Ecuador and the upper Amazon, with notes on other species. Proc. Acad. Nat. Sci. Philadelphia, 20, Mar. 1868, p. 96-140.

Describes *Bufo argillaceus* from Colima, México.

- 1869a. On the origin of genera. Proc. Acad. Nat. Sci. Philadelphia, 20, Oct. 1868, pp. 242-300.

Certain Mexican species and genera mentioned.

- 1869b. Sixth contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 20, 1868, pp. 305-313.

Lists *Spelerpes lineolus* from Córdoba, Veracruz, and *Geotriton carbonarius* from Yucatán.

- 1869c. A review of the species of the Plethodontidae and Desmognathidae. Proc. Acad. Nat. Sci. Philadelphia, 21, 1869 (May), pp. 93-118.

Treats of *Ophoeobatrachus lineolus*, *Oedipus carbonarius*, *Oedipus variegatus*, *Spelerpes bellii*, *S. cephalicus*, *S. chiropterus*. Type descriptions of *Oedipus rufescens*, *Spelerpes leprosus* and *Thorius pennatulus* appear.

- 1869d. Seventh contribution to the herpetology of tropical America. Proc. Amer. Philos. Soc., 11, July 1869, pp. 147-169, pls. 9-11.

Describes *Lyla rugulosa*, from Tehuantepec; also lists the following: *Cystignathus melanonotus*, *C. gracilis* and *Ranula affinis*.

- 1871a. On Siredon metamorphosis, etc. Amer. Journ. Sci. Arts., (3), 1, Feb. 1871, pp. 60-60.

States that the metamorphoses observed by Prof. Duméril were not of *Siredon mexicanus*.

- 1871b. Ninth contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia, 22, 1871, pp. 200-224.

Lists *Systoma ustum*, *Bufo aqua*, *Bufo sternosignatus* and *Lithodytes rhodopis*, from Tehuantepec.

- 1871c. On Siredon metamorphosis. Ann. Mag. Nat. Hist., (4), 7, 1871, pp. 246-247.

1874. Description of some species of reptiles obtained by Dr. John F. Bransford, assistant surgeon United States Navy, while attached to the Nicaraguan surveying expedition in 1873. Proc. Acad. Nat. Sci. Philadelphia, 25, pp. 64-72.

Type description of *Hyla ebraccata*, Nicaragua.

1875. Check-list of North American Batrachia and Reptilia, Bull. U. S. Nat. Mus. 1, pp. 1-104.
1876. On the Batrachia and Reptilia of Costa Rica. Journ. Acad. Nat. Sci. Philadelphia, (2), 8, 1876, pp. 93-154, pls. 23-28.
Type description of *Microphryne pustulosa* is given. *Bufo coccifer* is figured.
1877. Tenth contribution to the herpetology of tropical America. Proc. Amer. Philos. Soc., 17, No. 100, Aug. 1877, pp. 85-98.
Type descriptions of *Bufo canaliferus*, *Hyla spilomma*, *Hyla bistincta*, *Phyllobates cystignathoides* and *Cystignathus labialis*.
1878. Change by artificial means of a land to an aquatic salamander. Amer. Nat., 12, July 1878, pp. 468-469.
Mexican Ambystoma.
- 1879a. Eleventh contribution to the herpetology of tropical America. Proc. Amer. Philos. Soc., 18, No. 104, 1878-1880 (June 20, 1879 [Aug. 11 ?]) pp. 261-277.
Lists *Agalychnis dacnicolor* and *Bufo debilis* (probably *kelloggi*), from Mazatlán. From Guanajuato, *Spelerpes belli*, *Bufo punctatus*, *Bufo intermedius*, *Bufo monksiae* sp. nov., *Spea hammondi*, *Hyla eximia*, *Hyla arenicolor*, *Malachylodes guttilatus* sp. nov., *Cystignathus microtis* sp. nov., *Rana montezumae* and *Rana halecina* from Guanajuato; *Hypopachus variolosus* from Guadalajara; from Tehuantepec, *Oedipus rufescens*, *Oedipus carbonarius carbonarius*, *Oedipus carbonarius salvini*, *Siphonops mexicanus*, *Bufo aqua*, *Bufo sternosignatus*, *Bufo canaliferus*, *Bufo coccifer*, *Bufo valliiceps*, *Microphryne pustulosa*, *Engystoma ustum*, *Rhinophrynus dorsalis*, *Hyla miotympanum*, *Smilisca baudini*, *Hylella platycephala* sp. nov., *Lithodytes rhodopsis*, *Lithodytes podiciferus*, *Syrrophus leprus* sp. nov., *S. cystignathoides*, *Cystignathus melanotus*, *Cystignathus perlaevis* sp. nov., *C. microtis*, *C. gracilis*, *C. labialis*, *Ranula affinis*, *Rana halecina*.
- 1879b. A contribution to the zoology of Montana. Amer. Nat., 13, No. 7, July 1879, pp. 432-441.
Bufo dipternus is described from Montana.
- 1879c. Another siredon. Amer. Nat., 13, 1879, pp. 456-457.
1880. On the zoological position of Texas. Bull. U. S. Nat. Mus., No. 17, 1880, pp. 1-51.
Diemyctylus miniatus meridionalis described from Matamoros, Tamaulipas, México. Other species mentioned.
- 1885a. Twelfth contribution to the herpetology of tropical America. Proc. Amer. Philos. Soc., 22, No. 118, 1884 (1885), pp. 167-194, figs. 1-8.
Lists *Rana halecina* from Monterrey, and *Dermophis mexicanus*.
- 1885b. A contribution to the herpetology of Mexico. Proc. Amer. Philos. Soc., 22, No. 120, Apr. 1885, pp. 379-404.
Lists *Spelerpes belli*, *Bufo intermedius*, *Bufo aqua*, *Hyla nigropunctata*, *Hyla gracilipes*, *Smilisca baudini*, *Lithodytes rhodopsis*, *Hyla miotympanum*, *Rana halecina* and *Hyla arenicolor*. *Hypodictyon* proposed for *H. ridens* (= *Phyllobates ridens* Cope), and includes *verruculatus* and *H. calceus* Peters. *Syrrophus verrucipes* is described.
1887. Catalogue of batrachians and reptiles of Central America and Mexico. U. S. Nat. Mus. Bull., No. 32, 1887, pp. 1-98.
Lists the known Mexican Amphibia. The genus *Diaglena* is proposed.

1888. (No title.) Amer. Nat., 22, No. 253, Jan. 1888, p. 80. Mentions a frog described by Boulenger as *Hyla copiei* (sic) for (*copii*). In a footnote, it is referred to *H.(yla) arenicolor* Cope.
1889. The Batrachia of North America. Bull. U. S. Nat. Mus., No. 34, 1889, pp. 1-525, pls. 1-86, text figs. 1-119.
A few Mexican species recorded.
1893. Second addition to the knowledge of the batrachia and reptilia of Costa Rica. Proc. Amer. Philos. Soc., 31, No. 142, Nov. 17, 1893, pp. 333-347.
Comments on *Lithodytes rhodopsis*.
1896. The geographical distribution of Batrachia and Reptilia in North America. Amer. Nat., Nov. and Dec. 1896, pp. 886-902, 1003-1026.
Many Mexican species mentioned with relation to the various faunal provinces.
1900. The crocodilians, lizards, and snakes of North America. Ann. Report U. S. Nat. Mus., 1898 (1900), pp. i-xviii, 155-1294, pls. 1-36, text figs. 1-347.
Speleperpes leprosus mentioned p. 757, and numerous amphibians are listed in the discussion of the faunal districts.

CORNALIA, EMILIO.

1868. Gli Axolots del Museo civico di Milano. Rendic. R. Istit. Lombard., (2), 1, 1868, pp. 383-388.

CUNNINGHAM, J. T.

1887. Siredon in Encycl. Brit. Ed. 9, 22, pp. 96-97.
A good historical account.

CUESTA TERRON, CARLOS.

1930. La *Hyla eximia* Baird. Anal. Inst. Biol. 1 (2), 1930, pp. 47-50, figs. 1-4.

DARRENTH, C.

1874. Sur une particularité physiologique de l'Axolotl. Compt. Rend., 78, 1874, pp. 1656-1657.

DAUDIN, F. M.

1803. Histoire Naturelle, Générale et particulière des reptiles. Vols. 1-8, Paris, Year X-XI (1802-1803). Vol. 8, 1803, pp. 1-439.
Describes a Mexican axolotl.

DECKERT, RICHARD.

1915. Review of two series of amphibians. Zoologica, 2, No. 1, Oct. 1915, pp. 1-34, figs. 1-6.
Certain Mexican species mentioned.

DE JAGER, E. F. J.

1939. Contributions to the cranial anatomy of the Gymnophiona. Further points regarding the cranial anatomy of the genus *Dermophis*. Anat. Anz., 88, No. 11-15, June 28, 1939, pp. 193-222, 9(=14) text figs.

DE LILLA, JOSE.

1934. Nota preliminar acerca de la accion fisiologica del veneno de *Dermophis mexicanus*. Anal. Inst. Biol., México, 5, No. 4, 1934, pp. 323-326.

DESCHAUSSURE.

1866. () Verh. d. Schweiz Naturf. Gesell.
Einsiedeln, 1866, pp. 7.
Observations on the Mexican axolotl.

DEBOR, E.

1879. Quelques details sur les métamorphoses du *Sirenodon* (sic), Bull. Soc. Sci. Nat. Neuchâtel, 8, 1869-1870 (1870), pp. 266-269.

DÍAZ DE LEÓN, JESUS.

1904. Indice de los Batracios que se encuentran en la Republica Mexicana. Imprenta de Ricardo Rodriguez Romo. Aguascalientes, June 1904, pp. 1-40.

A compiled list of the Amphibia of México: 105 Salientia, 20 Urodela, and 1 Apoda are listed.

DICKERSON, MARY C.

1906. The Frog Book. New York, Doubleday, Page & Co. 1906, pp. xvii + 253. Color pls. 1-16, halftone pls. 1-95, 35 text figs.

DODDS, CLIFFORD T.

1923. A note on *Bufo marinus*. Copeia, 1923, No. 114, pp. 5-6. A specimen from Los Mochis, Sinaloa. Effect of venom on a dog.

DUGÈS, ALFREDO AUGUSTO DELSECAUTZ

1869. Catálogo de animales vertebrados observados en la República Mexicana. La Naturaleza, 1, 1869-1870 (1869), pp. 137-145.

Lists *Rana moctezumae* (sic), *R. halerina*, *R. longipes*, *Cystignathus caliginosus*, *Scaphiopus holbrooki*, *Hyla eximia*, *H. versicolor*, *Hylodes laticeps*, *Bufo aqua*, *B. anomalus*, *B. intermedius*, *B. chilensis*, *Engystoma* sp. nov. ?, *Bolitoglossa mexicana*, *Siredon lichenoides* and *Siredon lichenoides* var. *alba* (pescado nutria), México.

1870. Una nueva especie de ajolote de la Laguna de Pátzcuaro. La Naturaleza, 1, 1869-1870 (1870), pp. 241-244, pl. 5

Purports to be a type description of *Siredon Dumerilii*; the author states, "Sin: *Siredon Dumerilii*," as if published elsewhere.

1872. Note sur une nouvelle espèce d'axolotl (le *Siredon Dumerilii*) (Extraite d'une lettre adressée à M. *** et datée de Guanajuato, mai 1870). Ann. Sci. Nat. Paris, (5), 15, Art. 17, 1872, pp. (1-2), pl. 10.

1878. Programa de un curso de zoologia. Guanajuato. 8vo. ix + 257 + 8. Numerous reptile and amphibian species mentioned.

1879. *Hylodes augusti*, A Dugès. (In) Brocchi, Sur divers batraciens anoures de l'Amérique Centrale. Bull. Soc. Philom. Paris, (7), 3, pp. 19-24.

1884. Elementos de zoologia. Mexico (city). 8vo. pp. viii-479, 11 pls. Reptiles and amphibians, pp. 320-347, pl. 7.

Practically a list of Mexican reptiles and amphibians; some of the reptile illustrations are original.

1888. Erpetología del valle de México. La Naturaleza, (2), 1, Cuad. 2-4, 1887-1890 (1888), pp. 97-146, pls. 11-13, three figs. in text.

Lists *Hyla eximia*, *Rana moctezumae*, *Rana halerina*, *Bufo compactilis*, *Amblystoma carolinae*, *Amblystoma tigrinum*, *Siredon tigrinum* and *Siredon edule*. *Amblystoma Velasci* is proposed as a substitute for *Siredon tigrinum* Velasco.

1892. Descripción del esqueleto del *Rhinophrynus dorsalis*, D. B. La Naturaleza, (2), 2, Cuad. 2-4, 1891-1897 (1892), pp. 98-100, pl. 5, figs. 1-4.

1894. *Amblystoma altamirani*, A. Dug. La Naturaleza 2 (2nd Ser.), pp. 7-9, pl. 29, figs. 1-8.

1894. Lista de algunos reptiles y batracios de Tabasco y Chiapas, La Naturaleza (2), 2, Cuad. 7-8, 1892-1896 (1894), pp. 375-377.

Oedipus rufescens, *Spelerpes mexicanus*, *Bufo marinus*, *B. canalisferus*, *Rhinophrynus dorsalis*, *Hyla miotympanum*, *Smilisca baudini*, *Leptodactylus melanonotus*, *Leptodactylus echinatus* and *Dermophis mexicanus* are listed.

- 1895a. Fauna del estado de Guanajuato. (In) Memoria sobre la administracion publica del estado de Guanajuato presentada al congreso del mismo por el C. Gobernador constitucional Lic. Joaquin Obregón Gonzales, El 1 de Abril de 1895 Morelia.

Lists *Spelerpes Bellii*, *Amblystoma tigrinum*, *Bufo compactilis*, *Bufo intermedius*, *Bufo punctatus*, *Hyla arenicolor*, *Hyla eximia*, *Hylodes Augusti*, *Malachylodes guttilatus*, *Hypopachus variolosus*, *Scaphiopus Dugesii*, *Rana virescens* and *Rana Draytoni*.

- 1895b. Description d'un Axolotl de Montagnes de las Cruces (*Amblystoma altamirani* A. Dugès). Imprimerie du Ministère de "Fomento," 1895, pp. 1-6, 1 pl.

Original description of *Amblystoma altamirani* Dugès.

- 1895c. *Amblystoma altamirani*, A. Dug. (In) Fernando Altamirano, Sobre algunos excursiones a las montañas del Ajusco y Sierranía de las Cruces. Informe que rinde á la Secretaría de Fomento el Director del Instituto Médico Nacional, México, 1895, pp. 1-64, 1 pl.

Description, pp. 5-9, in French, and a Spanish translation under the title "El *Amblystoma altamirani*, A. Dug." on pp. 9-13. The French description was reprinted in the following paper.

- 1896a. *Amblystoma altamirani* A. Dugès. La Naturaleza, (2), 2, Cuad. 10-11, 1891-1897 (1896), pp. 459-461, pl. 29.

- 1896b. Reptiles y batracios de los E. U. Mexicanos. La Naturaleza, (2), 2, Cuad. 10-11, 1892-1896 (1896), pp. 479-485.

References to the then known Mexican species: *Oedipus rufescens*, *Spelerpes mexicanus*, *S. Mülleri*, *S. Bellii*, *S. leprosus*, *S. morio*, *S. chiropterus*, *Amblystoma tigrinum*, *A. altamirani*, *Siredon tigrinum*, *S. mexicanum*, *Bufo americanus*, *B. canalisferus*, *B. compactilis*, *B. marinus*, *B. intermedius*, *B. punctatus*, *Rhinophrynus dorsalis*, *Hyla arenicolor*, *H. eximia*, *H. miotympanum*, *Smilisca Baudini*, *Hylodes Augusti*, *Malachylodes guttilatus*, *Leptodactylus ocellatus*, *L. labialis*, *L. echinatus*, *L. microtis*, *L. melanonotus*, *Hypopachus variolosus*, *Scaphiopus Dugesii*, *Rana sphenoccephala*, *R. nigricans*, *R. virescens halcina*, *R. Montezumae*, *Dermophis mexicanus*.

1897. Influencia del medio ambiente sobre la readaptación. Mem. Soc. Cient. Ant. Alsate, 10, 1897, pp. 341-342.

(Account of an *Amblystoma* in adult state, except with degenerate non-filamentous branchiae, redeveloping fully formed branchiae when kept in an aquarium, while retaining all other adult characters.)

- 1901a. Experimento en un Ajolote. La Naturaleza, (2) 3, Cuad. 7-8, 1901, p. 562, pl. 36.

Amblystoma altamirani is discussed.

- 1901b. Sobre un *Amblystoma altamirani*. Mem. Soc. Cient. Antonio Alsate, 16, 1901, pp. 31-34, pl. 1.

DULTZ, ERNST.

1874. Züchtungsversuche mit einem Aquariumbewohner, dem axolotl (*Amblystoma Axolotl*). Gef. Weit., 3, 1874, pp. 195, 200-210.

1876. Züchtungsversuche mit dem Axolotl. *Isis* (Russian), 1, 1876, pp. 39-40, 47-48, 1 pl.

DUMÉRIL, ANDRÉ MARIE CONSTANT, BIBRON, GABRIEL and AUGUSTE HENRI ANDRÉ DUMÉRIL.

1841. *Erpétologie générale ou Histoire naturelle complète des 1854.*

Reptiles, Vols. 1-9 and Atlas. Paris 1834 to 1854.

Volume 8 (1841) and 9 (1854), treat of the Salientia and Urodela respectively. The atlas (1854) has a few illustrations of Mexican forms; a few Mexican species listed. Vols. 7 (both parts), 9, and the atlas were compiled by all three authors, but only André Duméril and Bibron are cited as authors of the other volumes.

DUMÉRIL, AUGUSTE.

1853. *Memoire sur les Batraciens Anoures de la famille des hylaeformes ou rainettes comprenant la description d'un genre nouveau et de onze espèces nouvelles.* Ann. Sci. Nat., (3) Zool. 19, 1853, pp. 135-179, pl. 7.

Contains the type descriptions of *Hyla moreletii*, (Guatemala) and *Hylodes laticeps*, Yucatán.

1863. Title?

Mem. Soc. Sci. Nat. Cherbourg, 9, 1863, pp. (23), fig. 10.

Siphonops mexicanus.

- 1865a. *Reproduction, dans la Ménagerie des Reptiles au Muséum d'Histoire naturelle, des axolotls, Batraciens, Urodèles à branchies persistantes de Mexico (Siredon Mexicanus, vel Humboldtii), qui n'avaient encore jamais été vus vivants en Europe.* Compt. Rend. l'Acad. Sci., 60, No. 14, 1865, pp. 765-767.

Cope has expressed the idea that the species treated here is not *Siredon mexicanus* as specimens were sent to Cope to examine.

- 1865b. *Nouvelles observations sur les axolotls nés à la Ménagerie.* Compt. Rend. l'Acad. Sci., 1865, p. 775

- 1865c. ———

Bull. Soc. Imp. d'Acclimat., II, 1865, p. 348.

- 1866a. *Observations faites à la Ménagerie des reptiles du muséum d'histoire naturelle sur reproduction des Axolotls, Batraciens urodèles à branchies extérieures et sur les Métamorphose qu'ils y ont subies.* Bull. Soc. Imp. Zool. d'Acclimat., (2), 3, 1866, pp. 79-89, figs.

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- 1922a. A new salamander from Mexico. *Proc. Biol. Soc. Washington*, 35, Mar. 20, 1922, pp. 5-6.
- Type description of *Oedipus townsendi*.
- 1922b. Two new insular Batrachoseps. *Copeia*, No. 109, Aug. 15, 1922, pp. 60-63.
- Batrachoseps leucopus* is described from North Island, Los Coronados, Baja California.
- 1922c. The sound-transmitting apparatus of salamanders and the phylogeny of the caudata. *Amer. Nat.*, 56, pp. 418-427.
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- 1922d. Notes on some tropical ranas. *Proc. Biol. Soc. Washington*, 35, Oct. 17, 1922, pp. 221-222.
- The specimen of *Rana pustulosa* in the Museum of Comparative Zoölogy, reported from Sinaloa, is a specimen of *Rana montezumae* (fide Oliver, *Oec. Papers Mus. Zoöl. Univ. Mich.*, No. 360, Nov. 20, 1937, p. 8).

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- 1924b. New amphibians from Panamá. Occ. Pap. Boston Soc. Nat. Hist., 5, 1924, pp. 93-95.
Mentions *Oedipus lineolus* from México, and discusses *Oedipina*.
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- 1928a. The habitats of Plethodontidae. Amer. Nat., 62, 1928, pp. 236-248.
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- 1928b. Notes on Central American caecilians. Proc. New England Zool. Club, 10, Oct. 11, 1928, pp. 71-76.
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- 1928c. A new genus of salamanders from Mexico. Proc. New England Zool. Club, 10, Nov. 3, 1928, pp. 85-86.
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terus, *S. variegatus*, *S. belli*, *Batrachoseps attenuatus*, *Scaphiopus dugesi*, *Rhinophryne dorsalis*, *Bufo valliceps*, *B. marinus*, *B. marmoreus*, *B. intermedius*, *Hyla baudini*, *H. eximia*, *H. staufferi*, *H. copei*, *Phyllomedusa dacnicolor*, *Hylodes rhodops*, *H. beatae*, *Eupemphix gadovii*, *Leptodactylus albilabris*, *L. caliginosus*, *Borborocoetes mexicanus*, *Syrnhopus verruculatus*, *Paludicola mexicana*, *Engystoma ustum*, *Rana montezumae*, *R. halcina*, *R. palmipes*; numerous other species are listed or discussed.

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Very numerous species mentioned.

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Numerous Mexican species are mentioned: *Thorius pennatulus*, *Spelerpes infuscatus*, *Amblystoma tigrinum*, *Scaphiopus multiplicatus*, *Bufo marinus*, *B. aqua*, *Rhinophrynus dorsalis*, *Ph.(yllo-medusa) dacnicolor*, *Triprion petasatus* and *Pternohyla fodiens*

1930. Jorullo. The history of the volcano of Jorullo and the reclamation of the devastated district by animals and plants. Cambridge Univ. Press, London, pp. xviii + 100, frontis. map, 2 figs.

Many data on reptiles and amphibians of Michoacán.

GAIGE, HELEN THOMPSON.

1936. Some reptiles and amphibians from Yucatan and Campeche, Mexico. Carnegie Inst. Washington Publ., No. 457, Feb. 5, 1936, pp. 289-304.

Lists *Rhinophrynus dorsalis*, *Bufo marinus*, *B. valliceps*, *Leptodactylus labialis*, *L. melanotus* (sic), *Triprion petasatus*, *Agalychnis callidryas*, *A. moreletii*, *Hyla baudinii*, *H. culex*, *H. venulosa*, *Hypopachus inguinalis* and *Rana pipiens*.

1937. Some amphibians and reptiles from Tamaulipas. (In) The geology and biology of the San Carlos Mountains. Univ. Michigan Studies, Sci. Ser. 12, 1937, pp. 301-304.

Lists *Rana pipiens*, *Bufo marinus*, *B. punctatus*, and *B. valliceps*.

GAERMAN, SAMUEL W.

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1887. Reptiles and batrachians from Texas and Mexico. Bull. Essex Inst., 19, 1887, pp. 119-138.

Lists *Rana montezumae*, *R. berlandieri*, *Engystoma carolinense*, *Paludicola nitida*, *Bufo valliceps*, *B. cognatus*, *B. speciosus*, *B. compactilis*, *Hyla eximia*, *Scaphiopus couchii* and *Amblystoma mexicanum*.

GERSTÄCKER, A.

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1873. Hybridation des Axolotls par les Tritons. Journ. de Zool. (Gervais), 2, 1873, pp. 245-249.

GEYER, H.

1926. Ueber Schilddrüsenverfütterung an Axolotl. Blätt. Aquar-Terrarienk., 37, 1926, p. 241.

GIRARD, CHARLES.

1854. A list of the North American bufonids, with diagnoses of new species. Proc. Acad. Nat. Sci. Philadelphia, 7, 1854-1855 (May 1854), pp. 86-88.

Lists the following from México: *Bufo woodhousii*, *B. speciosus* and *B. punctatus*. Type descriptions are given of *Bufo debilis*, *B. nebulifer*, and *B. insidiosus*.

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GOMEZ, ISAAC CANCINO.

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1926. Ranita parda.-*Hylodes venustus* Gunther. Mem. Rev. Soc. Cient. "Antonio Alsate," 46, March to June, 1926, pp. 223-225.

GRIFFITHS, EDWARD, and PIDGEON, EDWARD.

1831. The class Reptilia, arranged by the Baron C. Cuvier, with specific descriptions. Vol. 9, of The Animal Kingdom arranged in conformity with its organization by the Baron Cuvier with additional descriptions of all the species hitherto named, and of many others. 1831, pp. 1-481, pls. 1-55 not numbered

Siren pisciformis discussed and figured.

GRAVENHORST, J. L. C.

1829. Deliciae Musei zoologici Vratislaviensis Fasciculus Primus continens chelonios et Batrachia. Lipsiae, Leopoldi Vossii.

Treats of *Hypochthon pisciformis*.

GRAY, JOHN EDWARD.

1831. A synopsis of the species of the class Reptilia. pp. 1-110. (In) Griffiths's The Animal Kingdom arranged in conformity with its organization by the Baron Cuvier, etc. Vol. 9, 1831.

Phyllhydrus pisceformormis (sic), *Salamandra variegata* (and in synonymy, *Salamandre platydactyla* Cuv., Mus. Paris) "Brown with irregular dorsal bands. Mexico."

1850. Catalogue of the specimens of amphibia in the collection of the British Museum. Part II. Batrachia Gradientia. 1850, pp. 1-73, pls. 3-4.

Contains references to certain Mexican species.

GÜNTHER, ALBERT CARL LUDWIG GOTTHELF.

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1859. Catalogue of the Batrachia Salientia in the collection of the British Museum. London 1858 (Feb. 12, 1859), pp. xvi + 160, pls. 1-12.

Lists the following from México: *Rana haeleina*, *R. lecontii*, *Engystoma carolinense*, *E. rugosum*, *Bufo anomalus* sp. nov., *B. lentiginosus* Var. B., *B. musicus*, *B. aqua*, *B. nebulifer*, *B. sternosignatus*, *Hylodes laticeps*, *H. lichenosa* sp. nov., *H. versicolor*, *H. baudinii*, *H. euphorbiacea* sp. nov., *Nototrema marsupiatum*, *Rhinophrynus dorsalis*.

1868. First account of species of tailless batrachians added to the collection of the British Museum. Proc. Zool. Soc. London, 1868 (June 25), pp. 478-490, pls. 37-40.

Hylodes sallei described from México.

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1882. Notice of a second species of *Tripurion*. Ann. Mag. Nat. Hist., (5), 10, No. 58, Oct. 1882, p. 279.

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1885-1902, pp. xx + 326, pls. 1-76.

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HAHN, G.

1892. Las Ajolotes y su metamorfosis (translated from "Revue des questions scientifiques" Bruselas (2), I, 1892, p. 178), La Naturaleza, (2), 2, 1892, pp. 218-230. Original not seen.

HALLOWELL, EDWARD.

1852. Descriptions of new species of reptiles inhabiting North America. Proc. Acad. Nat. Sci. Philadelphia, 6, Oct. 1852, pp. 177-182.

Bufo dorsalis is described from New Mexico.

1856. Description of several species of Urodela, with remarks on the geographic distribution of the Caducibranchiate division of these animals and their classification. Proc. Acad. Nat. Sci. Philadelphia, 8, Feb. 1856, pp. 6-11.

Spelerpes mexicanus is referred to the family Bolitoglossidae.

1861. Report upon the Reptilia of the North Pacific Exploring Expedition, under the command of Capt. John Rogers, U. S. N. Proc. Acad. Nat. Sci. Philadelphia, 12, Oct. 1860, pp. 490-496. (Edited by E. D. Cope.)

Describes *Cystignathus melanonotus* (Nicaragua), *Hyla grisea* (? Nicaragua) and *Bufo melanogaster* (Nicaragua).

HARLAN, RICHARD.

1826. Description of several new species of batrachian reptiles, with observations on the larvae of frogs. Silliman's Journ. 10, (1), pp. 53-65.

Rana ocellata stated to occur in México.

HARTING, PETER.

1865. Eierlegging bevruchting en ontwikkeling van den Axolotl. Album der Natuur., 1865 (Wetensch. bijblad.), p. 44.
1866. Metamorphose van den Axolotl. Album der Natuur., 1866 (Wetensch. bijblad), pp. 2-3.
1867. Verkregen polydactylie der Axolotls. Album der Natuur., 1867 (Wetensch. bijblad), p. 77.
1870. Ronddraaiing van de embryo in de eieren van den Axolotl. Album der Natuur., 1870 (Wetensch. bijblad), p. 50.
1874. Menstruatie bij den Axolotl. Album der Natuur., 1874 (Wetensch. bijblad), p. 75.
1879. Hoe men Axolotls ten allen tijde tot het leggen van eieren brengt. Album der Natuur., 1879 (Wetensch. bijblad), p. 39 (Semper, Zool. Ans., 1, 1878, p. 176.)

HARTWEG, NORMAN.

1941. Notes on the genus *Plectrohyla*, with descriptions of new species. Occ. Papers Mus. Zool., Univ. Michigan, No. 437, June 30, 1941, pp. 1-10, pl. 1.

Plectrohyla sagorum and *Plectrohyla matudai* are described.

HARTWEG, NORMAN, and OLIVER, JAMES A.

1940. A contribution to the herpetology of the Isthmus of Tehuantepec. IV. Misc. Publ. Mus. Zool., Univ. Michigan, No. 47, July 13, 1940, pp. 1-31.

Lists *Bufo coccifer*, *B. marinus*, *B. marmoreus*, *Rhinophrynus dorsalis*, *Engystomops pustulosus*, *Leptodactylus labialis*, *L. melanotus*, *Eleutherodactylus augusti*, *Hyla baudinii*, *H. staufferi*, *Microhyla usta*, *Rana pipiens*.

HARTWEG, NORMAN, and ORTON, GRACE.

1941. Notes on tadpoles of the genus *Plectrohyla*. Occ. Papers Mus. Zool., Univ. Michigan, No. 438, July 1, 1941, pp. 1-6, figs. 1-2.

The tadpoles of *Plectrohyla* "form a" and *Plectrohyla* "form b" are described.

HASSE, C.

1873. Ueber den Bau des Gehörorgans von *Siredon pisciformis* u. über die vergleichende Anatomie des Kiefersuspensorium. Anat. Stud. (Hasse), 4, 1873, pp. 611-647, 1 pl.

HAY, W.

1867. Monografía sobre el lago de Texcoco. Arch. de la Comm. Sci. du Mexique, 1867, II, pp. 311-333.

HECHT, MAX K., and MATALAS, BESSIE L.

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HERRE, WOLF.

1935. Ueber *Oligosemia spinosa* Navás, einen fossilen Schwanslurch aus dem spanischen Tertiär. Paleont. Zeit. 17, Nos. 1-2, Aug. 30, 1935, pp. 91-105, figs. 1-4.

Discusses the anatomy and figures the cranium of *Diemyscylus kallerti*.

1936. Ueber Rasse und Artbildung, Studien an Salamandriden. Abh. Ber. Mus. Natur. Vorges. Natur. Ver. Magdeburg, 6, No. 3, 1936, pp. 193-221.
- HERRERA, ALFONSO L. (HJJO).
1890. Notas acerca de los vertebrados del valle de México. La Naturaleza (2), 1, Cuad. 7-9, 1890, pp. 299-342.
Lists Hyla eximia, Rana montezumae, R. halecine, Bufo compactilis, Amblystoma carolinae, A. tigrinum, Siredon edule, Spelerpes morio and S. orculus.
- 1891-1893. El clima del valle de México y la biología de los vertebrados. La Naturaleza, (2), 2, Cuad. 1, 1891, pp. 38-64, and Cuad. 2-4, 1892, pp. 64-86, Cuad. 5-6, 1893, pp. 324-358.
Mentions Bufo compactilis, Spelerpes morio, Amblystoma tigrinum, Spelerpes orculus, Scaphiopus dugesi and Rana halecina.
1895. Catálogo de la colección de reptiles y batracios del Museo Nacional. Mexico, 1895, pp. 1-66.
The following species are listed: Siphonops mexicana, Rana montezumae, R. halecina, Scaphiopus dugesi, Hyla eximia, H. versicolor, Bufo americanus, B. compactilis, B. aqua, B. musicus, Plethodon erythronotum, Spelerpes morio, S. mexicanus and Amblystoma tigrinum; 2nd Edit. 1904, pp. 1-65. Same species listed.
1900. El Ajolote sufre la metamorfosis general en la clase de los batracios por aumento de nutrición y no por cambio de medio. La Naturaleza, (2), 3, Cuad. 5-6, 1899 (1900) pp. 367-376.
- HERTWIG, OSCAR.
1874. Ueber das Zahnsystem der Amphibien und seine Bedeutung für die Genesis des Skelets der Mundhöhle. Arch. f. Mikros. Anat., 11, Supp. 1, 1874, pp. i-viii, 1-208, pls. 1-5.
- HOLLIS, MARGARITA BRAVO.
1941. Revision de los generos *Diplodiscus* Diesing, 1836 y *megalodiscus* Chandler, 1923, (Trematodi: Paramphistomodea). I. Anal. Inst. Biol. Mex., 12, 1941, pp. 127-146.
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- HOME, EVER.
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1897. Lehrbuch der Zoologie 1897, p. 29, fig. 5.
- HÖRSTADIUS, S., and SELLMAN, S.
1942. Experimental studies on the determination of the chondrocranium in *Amblystoma mexicanum*. Ark. Zool. Stockholm, 33A (13), pp. 1-8, figs.
- HUMPHREY, R. R.
1935. Sex reversal in *Amblystoma*. VIII. Sex type of gonads developed from gonadic preprimordia of *A. punctatum* implanted in axolotl females. Proc. Soc. Exp. Biol. and Med., 33, pp. 102-104.
1938. Studies on sex reversal in Amphibia. XI. Reversal in *A. tigrinum* females induced by ectopic implantation of testis preprimordia. Anat. Rec. 72, pp. 451-467, pl. 1, table 1, figs. 1-2.

1939. The growth of gonads derived from heteroplastic transplants of their preprimordia in *Amblystoma*. Amer. Journ. Anat. 65, pp. 35-67, pls. 1-3, charts 1-4, tables 1-4.
1941. Adult Artificial hermaphrodites in *Amblystoma tigrinum* and *mexicanum*. Amer. Journ. Anat. 69, pp. 19-59, pls. 1-3, tables 1-2, figs. 1-13.
- 1942a. Sex of the offspring fathered by two *Amblystoma* females experimentally converted into males. Anat. Rec. 82 (3) (suppl.), p. 77.
- 1942b. Sex reversal and the genetics of sex determination in the axolotl (*Amblystoma mexicanum*). Anat. Rec. 84, (4) (suppl.), p. 15.
- 1942c. Sex inversion in the amphibia. Biol. Symp. 9, pp. 81-104, figs. 1-16.
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- HUMPHREY, R. R. and BURNS, R. K., JR.
1939. An incompatibility manifested in heteroplastic parabiosis or grafting in *Amblystoma* due to a toxin of cutaneous origin. Journ. Exp. Biol. 81, pp. 1-42, figs. 1-14.
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1892. Reptiles and batrachians from northern Yucatan and Mexico. Proc. Acad. Nat. Sci. Philadelphia, 1891 (Jan. 19, 1892), pp. 458-463.
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- JENSEN, C. O.
1921. Partiel Metamorfose hos *Amblystoma mexicanum*. Vidensk. Medd. fra Dansk Naturh. Foren., 72, 1921, pp. 173-180. fig.
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1868. Note sur des axolotils nés à la ménagerie des reptiles du Muséum d'histoire Naturelle de Paris, et rapportés vivants à Toulouse. Mém. l'Acad. imp. Sci. Insc. Bel.-Lët. Toulouse, (6), 6, 1868, pp. 192-197.
1870. Sur la rotation de l'embryon dans l'oeuf des Axalotils du Mexique. (Lettre à M. Dumas.) Compt. Rend., 70, 1870, pp. 873-875.
1872. Etude sur la métamorphoses des Axolotils du Mexique (*Siredon mexicanus* Shaw). Developpment et rotation de leur embryon dans l'oeuf. Revue Scienc. Nat. 1, 1872, pp. 7-20.
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1877. Recherches sur le système circulatoire de l'Axolotl. Bull. Soc. Sci. Nancy, (2), 3, 1877, p. 27-28.

KEFERSTEIN, WILHELM.

1867. Ueber einige neue oder seltene Batrachier aus Australien und dem tropischen Amerika. Univ. Göttingen Nach. König. Gesell. Wiss., No. 18, July 24, 1867, pp. 341-363.

Contains the descriptions of the genus *Hypopachus*. (A part of this paper was republished in Wiegmann Arch. Natur., 1868, pp. 291-300, pls. 8-9 (not seen), *vide* Günther, Zool. Rec. for 1868.)

KELLOGG, REMINGTON.

1932. Mexican tailless amphibians in the United States National Museum. U. S. Nat. Mus. Bull., No. 160, 1932, pp. iv + 224, 1 pl., figs. 1-24.

Sixty-five species are recognized. The most important work on the Mexican Salientia.

KIRBY, JOSIAH.

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KNAUER, DR. FRIEDRICH K.

1878. Naturgeschichte der Lurche (Amphibiologie). Wien 1878, pp. i-xx, 1-340, figs. 1-120, 4 karten, 12 tab. Discussion of *Siredon mexicana*.

KOCH, M.

1926. Zur Umwandlung des mexikanischen Axolotls mittels Schilddrüsen-fütterung. Blatt. Aquar.-Terrarienk. 37, 1926, p. 245.

KOLLIKER, ALB.

- 1868a. Sur le développement des Axolotls. Verh. Schweiz. naturf. Ges. Einsiedeln, 52 Vers. 1868, pp. 87-89.

- 1868b. Remarques de plusieurs zoologistes sur la transformation de l'Axolotl. Verh. Schw. Naturf. Ges. Einsiedeln, 52, Vers. 1868, pp. 89-90.

1869. Ueber den mexikanischen Axolotl. Verh. Phys.-medic. Ges. Würzburg, N. F., 1, 1869, Sitzber. 1868, pp. xxiii-xxiv.

KOLLMAN, J.

1884. Das Ueberwintern von europäischen Frosch- und Tritonlarven und die Unwaldung des mexikanischen Axolotl. Verh. Natur. Gesell. Basel 1883, pp. 387-398, fig. 1-2.

KRUMSIEGEL, I.

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LAFRENTZ, K.

- 1927a. Aus der Heimat des Axolotl. Blätt. Aquar.-Terrarienk, 38, 1927, p. 160.

- 1927b. Reptilien, Amphibien und Fische des mexikanischen Hochlandes. Blätt. Aquar.-Terrarienk., 38, 1927, pp. 318-325, 3 figs.

- 1928a. Neue Beobachtungen an Amphibien des mexikanischen Hochlandes. Blätt. Aquar.-Terrarienk., 39, 1928, pp. 89-92, 110-115, 5 figs.

Oedipus bellii, *O. sulcatum* (fig. 3), *Hyla eximia*, *Hyla* sp. (bocourti ?) (fig. 4), *Bufo compactilis*, fig. 5.

- 1928b. Reisebriefe aus Mexiko. Blätt. Aquar.-Terrarienk., 39, 1928, pp. 115-116, 1 fig.

- 1930a. Mexikanische Urnenpflanzenmolche (*Oedipus* sp.). Blätt. Aquar.-Terrarienk., 41, No. 4, Feb. 28, 1930, pp. 61-63, pl. 8.

This species is later described as *Oedipus macrinii*, in two publications.

- 1930b. Ein neuer Plethodont-Salamander aus Mexiko. (In) Beiträge zur Herpetologie Mexikos, Abh. Ber. Mus. Natur-Heimat. naturw. Ver. Magdeburg, 6, No. 2, 1930, pp. 150-162.

Type description of *Oedipus macrinii*.

- 1930c. Untersuchungen über die Lebensgeschichte mexikanischer Ambystoma-Arten. (In) Beiträge zur Herpetologie Mexikos, Abh. Ber. Mus. Natur. Heimat. naturw. Ver. Magdeburg, 6, No. 2, 1930, pp. 91-127, three maps, pls. 2-3.

Treats of *Ambystoma dumerili*, *A. mexicanum*, *A. tigrinum velascoi* (Type description), and *A. altamirani*.

1931. Ein neuer Plethodont-Salamander aus Mexiko, *Oedipus macrinii* sp. n. Blätt. Aquar.-Terrarienk., 42, No. 4, Feb. 28, 1931, pp. 55-56, 1 fig.

Purports to be the original description of *Oedipus macrinii*.

LAMPE, EDUARD.

1902. Catalog der Reptilien und Amphibien Sammlung (Schlangen; Frosch-, Schwanz- und Schleichenlurche) des Naturhistorischen Museums zu Weisbaden. Jahrb. Nassau Ver. Naturk., 55, 1902, pp. 1-66.

Lists *Rana haeleina*, *Engystoma ustum*, *Bufo valliceps*, *Scaphiopus dugesi*, *Molge viridescens* and *Ambystoma tigrinum*.

LAURENTI, JOSEPH NICOLAI.

1768. Specimen medicum, exhibens synopsis Reptilium emendatum cum experimentis circa venena et antidota reptilium Austriacorum. Viennae, 1768, pp. 1-214, pls. 1-5.

Type description of *Hyla venulosa*.

LESSONA, MICH.

1877. Nota di un Axolotl del museo zoologico di Torino. Atti. R. Accad. Sci. Torino, 13, 1877-1878 (1877) pp. 137-139.

LINNÉ, CAROLUS VON (LINNAEUS).

1758. Systema Naturae, 10th Edit. Vol. 1, 1758, p. 211.

Rana marina described.

LINSDALE, JEAN M.

1932. Amphibians and Reptiles from Lower California. Univ. California Public. Zool. 38, No. 6, June 24, 1932, pp. 345-386.

The following species are treated in this work: *Scaphiopus couchii*, *S. hammondi*, *Bufo boreas halophilus*, *B. cognatus*, *B. californicus*, *B. punctatus*, *B. woodhousii*, *Hyla arenicolor*, *H. regilla*, *Rana aurora draytonii*.

1933. A specimen of *Rana tarahumarae* from New Mexico. Copeia, No. 4, Dec. 27, 1933, p. 222.

LIPSETT, JAMES C.

1939. Cleavage and early development in species hybrids. Bull. School Med. Univ. Md., 23 (4), p. 212.

LOCKINGTON, W. N.

1880. List of California reptiles and batrachia collected by Mr. Dunn and Mr. W. J. Fisher in 1876. Amer. Naturalist, 14, 1880, pp. 296-296.

Batrachoseps attenuatus.

LONG, STEPHEN H.

1823. Account of an expedition from Pittsburgh to the Rocky Mountains performed in the years 1819 and '20. Vols. 1-3, Philadelphia, H. C. Carey and I. Lea, 1823, pp. 6 + 442 + xviii.

Vol. 2 contains the original description of *Bufo cognatus* Say.

LÖNNBERG, EINAR.

1899. Salamanders with and without lungs. *Zool. Anz.*, 22, Dec. 28, 1899, No. 604, pp. 545-548.

Spelerpes variegatus lacks lungs.

LUBACH, D.

- 1867a. Gevolgen van het wegnemen der Kieuwen bij den Axolotl. *Album der Natuur.*, 1867 (*Wetensch. bijblad.*), p. 77 (see Duméril in *Compt. Rend.*, 65, p. 242).
- 1867b. Regeneratie der ledematen bij den Axolotl. *Album der Natuur.*, 1867 (*Wetensch. bijblad.*), p. 63.
1870. De Axolotls de Parijs. *Album der Natuur.*, 1870 (*Wetensch. bijblad.*), pp. 44-45. (See A. Duméril, *Les Mondes*, 1870, Apr. 21, p. 727.)

LÜTKEN, CHR.

1877. Nyere, Jagttagelser over Axolotl'en (*Med traesmit*). *Tidskr. popul. Mremstilling af Naturvidensk.*, 5, R. 4, 1877, pp. 109-131.

LYDEKKER, RICHARD, CUNNINGHAM, J. T., BOULENGER, G. A., and THOMPSON, ARTHUR.

1912. *Reptiles, Amphibia, Fishes and Lower Chordata*. London, 1912, pp. xvi + 510, pls. 1-36, text figs. 32, 1 map.

MALBRANC, M.

1872. Ueber das Sperma von Siredon. *Verh. d. Phys-medice Ges. Wurzburg*, N. F., 3, 1872, pp. 136-140.

MALFATTI, GIOVANNI.

1873. Axolotls allevati nel Museo Civico. *Atti. Soc. Ital. Sc. Nat.*, 16, 1873, pp. 141-147.

MARHEER, E.

1927. Zur Haltung von *Rana montezumae* (Baird). *Blätt. Aquar. Terr.* Kunde 38, (18) 1927, p. 373.

MARSH, O. C.

1868. Observations on the metamorphosis of Siredon into *Amblystoma*. *Amer. Journ. Sci. Arts*, (2), 46, Nov. 1868, pp. 364-374, 1 pl.

Mentions *Siredon mexicanus*.

- 1869a. Observations on the metamorphosis of Siredon into *Amblystoma*. *Zoologist*, (2), 4, 1869, pp. 1569-1580.

- 1869b. Observations on the metamorphosis of Siredon into *Amblystoma*. *Proc. Boston Soc. Nat. Hist.*, 12, 1868-1869 (1869) pp. 97-98.

- 1869c. Siredon, a larval Salamander. (*Abstr.*) *Amer. Nat.*, 2, 1869, p. 493.

MARTÍN DEL CAMPO, RAFAEL.

1932. *Dermophis mexicanus* (Dum. et Bibr.) (*Appendice to "Nota acerca de la histologia de la piel de Dermophis mexicanus Dum. y Bibr." by L. Ochoterena.*) *Anal. Inst. Biol.*, 3, No. 4, 1932, pp. 369-370.

A description and synonymy of *Dermophis mexicanus*.

1934. El organo de Bidder en *Bufo marinus* L. *Anal. Inst. Biol.* 5, No. 1, 1934, pp. 49-54, text figs. 1-4.

- 1936a. Contribuciones al conocimiento de la fauna de Actopan, Hgo. IV. Vertebrados observados en la epoca de las secas. *Anal. Inst. Biol.*, 7, Nos. 2-3, 1936, pp. 271-286, figs. 1-7.

Amblystoma tigrinum, *Scaphiopus hammondi multiplicatus*, *Bufo sinus*, *Hyla arenicolor*, *Rana monterumae* and *R. pipiens*.

1936b. Los batracios y reptiles segun los codices y relatos de los antiguos mexicanos. Anal. Inst. Biol., 7, 1936, pp. 469-513, figs. 1-18.

1937. Contribucion al conocimiento de los batracios y reptiles del valle del Mesquital, Hgo. Anal. Inst. Biol., 8, No. 1-2, 1937, pp. 259-266, figs. 1-5.

Amblystoma tigrinum, *Oedipus bellii*, *Scaphiopus hammondi multiplicatus*, *Bufo sinus*, *Hyla arenicolor*, *H. eximia*, *Rana montesumae* and *R. verde*.

1940a. Los Vertebrados de Pátscuaro. Anal. Inst. Biol., 11, No. 2, 1940, pp. 481-492.

Lists *Oedipus bellii*, *Bathysiredon dumerili*, *Hyla eximia* and *Rana pipiens*.

1940b. Nota acerca de algunos vertebrados de las lagunas de Campoala y sus alrededores. Anal. Inst. Biol., 11, No. 2, 1940, pp. 741-743, 1 fig.

Lists *Rhyacosedon altamirani*, *Hyla lafrentsi*, and *Rana pipiens*.

1940c. Una observacion del desarrollo de *Tomodactylus nitidus*. Anal. Inst. Biol., 11, No. 2, 1940, pp. 745-746, 1 fig.

1941. Ensayo de interpretacion del libro undécimo de la historia general de las cosas de Nueva España, de Fray Bernardino Sahagun III. Los Mamíferos. Anal. Inst. Biol. 12, 1941, pp. 489-506.

A few amphibians mentioned.

1942a. Relacion de algunos peces anfibios y reptiles de Masatlán, Sin. Anal. Inst. Biol., 12, (2) 1942, pp. 759-761.

1942b. Anfibios, Reptiles y Aves de la región de Haujuapan de León, Oax. Anal. Inst. Biol. Mexico, XIII, No. 1, 1942, pp. 351-355.

A few amphibians mentioned.

MARTÍNEZ GRACIADA, MANUEL.

1891. Catálogos de la flora y la fauna del Estado de Oaxaca. Emp. del Estado. 1891 pp. 1-84 (Batracios 83-84).

A number of species listed.

MEARNS, EDGAR ALEXANDER.

1907. Mammals of the Mexican Boundary of the United States. U. S. Nat. Mus. Bull. No. 86, pt. 1, 1907, pp. xv + 530, figs. 1-126, pls. 1-13.

Mentions some amphibians of the Mexican boundary.

MEIER, HERMANN.

1872. Der Axolotl. Natur. (Ule und Müller), 21, Bd. 1872, pp. 244-246.

MERREM, BLASIVS.

1820. Versuch eines Systema der Amphibien. Tentamen systematis amphibiorum. Marburg, pp. xv+191, 1 pl.

MERTENS, ROBERT.

1930. Bemerkungen über die von Herrn Dr. K. Lafrents in Mexiko gesammelten Amphibien und Reptilien. (In) "Beiträge zur Herpetologie Mexikos." Abh. Ber. Mus. Natur. Heimatk. Naturw. Ver. Magdeburg, 6, No. 2, 1930, pp. 153-161, 3 text figs.

Original description of *Gymnopsis multiplicata oaxacae*. Also discusses *Bufo compactilis*, *Eleutherodactylus rugulosus*, *Hyla eximia*, *H. lafrentsi*, *H. sumichrasti*, *Rana pipiens*, and *R. montesumae*.

MEXIKWA, ROBERT, and WOLFFSTORFF, WILLY.

1929. Ein neuer Laubfrosch aus Mexiko. Zool. Ans. 84, No. 9-10, Aug. 25, 1929, pp. 235-241.

Hyla lafrentsi is described, from Desierto de los Leones, Mexico. México.

MEYER, R.

1865. Fortpflanzung der Kolbenmouche aus Mexiko (Axolotl) in Paris. Zool. Garten, 6, 1865, pp. 352-353, and 7, 1866, p. 155.

1876. Ueber Fortpflanzung der Amblystomen im pariser Museum. Zool. Garten, 17, 1876, pp. 380-381.

MILLER, LOYE, and MILLER, ALDEN.

1936. The northward occurrence of *Bufo californicus* in California. Copeia, No. 3, Nov. 15, 1936, p. 176.

MIVART, ST. GEORGE.

1887. On the axial skeleton of Urodela. Proc. Zool. Soc. London, Apr. 28, 1887, pp. 260-278, several figs.

Mentions some points on the skeleton of the Mexican Axolotl.

MOCQUARD, M. F.

1899a. Reptiles et batraciens recueillis au Mexique par M. León Diguett en 1896 et 1897. Bull. Soc. Philom. Paris. (9), 1, No. 4, 1898-1899 (1899) pp. 154-169, pl. 1.

Describes as new *Rana trilobata*, *Hyla rudis* and *Hyliola Diguetti*. The following are discussed: *Rana lecontei*, *R. montezumae*, *Hypopachus variolosus*, *Hylodes augusti*, *Leptodactylus caliginosus*, *Hyliola Bocourti*, *Hyliola eximia*, *Hyliola staufferi*, *Bufo marinus*, *B. compactilis*, *B. alvarius*, *Scaphiopus dugesi*.

1899b. Contribution a la faune herpétologique de la Basse Californie. Nouv. Arch. Mus. Hist. Nat. Paris, (4) 1, 1899, pp. 297-343, pls. 11-13.

The following are mentioned or discussed: *Hyla regilla*, *H. plicata*, *H. staufferi*, *H. eximia*, *H. baudini*, *H. venulosa*, *H. arenicolor*, *H. nigropunctata*, *Agalychnis callidryas*, *Triprion petasatus*, *Bufo coccifer*?, *Scaphiopus couchii*. Describes the genus *Hyliola* and refers *bocourti*, *Hyla staufferi*, *Hyla plicata*, and *Hyla regilla* to it.

MOHR, JOHN LUTHER.

1941. Protozoarios parásitos de cincuenta *Hyla eximia* Baird, capturadas en Coyoacan, D. F., Mexico. Rev. Soc. Mex. Hist. Nat. 2 (4), pp. 261-266.

MOORE, JOHN ALEXANDER.

1944. Geographic variation in *Rana pipiens* Schreber of eastern North America. Bull. AMNH 82 (8), pp. 345-370, text figs. 1-3, pls. 61-66, tables 1-5.

MOORE, PERCY J.

1900. Post larval changes in the vertebral articulations of *Spelerpes* and other salamanders. Proc. Acad. Nat. Sci. Philadelphia, 1900, pp. 613-622.

The vertebrae of *Oedipus variegatus* and *Spelerpes bellii* are discussed.

MULAIK, STANLEY.

1937. Notes on *Leptodactylus labialis* (Cope). Copeia 1, pp. 72-73, fig.

MULAIK, STANLEY, and SALLBERGER, DWIGHT.

1938. Notes on the eggs and habits of *Hypopachus cuneus* Cope. Copeia 2, p. 90.

MÜLLER, F.

1878. Katalog der im Museum und Universitätskabinett zu Basel aufgestellten Amphibien und Reptilien nebst Anmerkungen. Verh. Naturf. Ges. Basel, 6, 1878, pp. 561-709, pls. 1-3.

Siredon pisciformis and *Spelerpes variegatus* are listed.

1835. Vierter Nachtrag zum Katalog der herpetologischen Sammlung des Basler Museums. Verh. Naturf. Ges. Basel, 7, No. 3, 1835, pp. 668-717, pls. 9-11.

Lists *Leptodactylus caliginosus* !! Presidio bei Masatlan.

MÜLLER, J. W. VON.

1865. Beiträge zur Geschichte, Statistik und Reisen in den Vereinigten Staaten, Canada und Mexiko. Vol. 13 1865. (Zoologie von Mexico, Amphibien), Vol. 3, pp. 595-620.

Rana adrita is described as new by Michael. 37 other species of Salientia are listed, 7 Caudata, and 1 Apoda. Whether this actually is a list of specimens collected or merely a compilation is not evident. The list is especially untrustworthy.

MYERS, GEORGE S.

1942. Notes on Pacific coast *Triturus*. Copeia, No. 2, July 16, 1942, pp. 77-82.

Deals with *Triturus torosus*.

NICHOLLS, GEORGE E.

1916. The structure of the vertebral column in the Anura *Phaneroglossa* and its importance as a basis of classification. Proc. Linn. Soc. London, 128 (1915-1916), pp. 80-92, figs. A-D.

NIEDEN, FRITZ.

1913. Gymnophiona (Amphibia Apoda). Das Tierreich, Lief. 37, 1913, pp. x + 31.

Mexican species described.

1923. Anura I. Subordo Aglossa und Phaneroglossa, Sectio. 1, Arcifera. Das Tierreich, Lief. 46, 1923, pp. xxxii + 584.

Mexican species described.

1926. Anura II. Engystomatidae. Das Tierreich, Lief. 49, 1926, pp. xvi + 110.

Mexican species described.

NOBLE, G. K.

1918. The amphibians collected by the American Museum Expedition to Nicaragua in 1916. Bull. Amer. Mus. Nat. Hist., 38, Art. 10, June 20, 1918, pp. 311-347, pls. 14-19, figs. 1-6.

1921. The anterior cranial elements of *Oedipus* and certain other salamanders. Bull. Amer. Mus. Nat. Hist. 44, Art. 1, March 18, 1921, pp. 1-6, pls. 1-2.

The skull of *Speleperpes leprosus* is figured.

1922. The phylogeny of the Salientia I. The osteology and the thigh musculature; their bearing on classification and phylogeny. Bull. Amer. Mus. Nat. Hist., 46, 1922, pp. 1-87, pls. 1-23.

1924. Some neotropical batrachians preserved in the United States National Museum with a note on the secondary sexual characters of these and other amphibians. Proc. Biol. Soc. Washington, 37, Feb. 21, 1924, pp. 65-71.

Refers *Hyla fleischmanni* to *Centrolenella*.

1925. An outline of the relation of ontogeny to phylogeny within the amphibia II. Amer. Mus. Nov., No. 166, 1925, pp. 1-10.

- 1927a. The value of life history data in the study of the evolution of the amphibia. Ann. New York Acad. Sci., 30, Oct. 31, 1927, pp. 31-123, pl. 9.

1927b. The plethodontid salamanders; some aspects of their evolution. Amer. Mus. Nov., No. 249, 1927, pp. 1-26, figs. 1-10.

1931. The Biology of the Amphibia. McGraw-Hill, New York, 1931, pp. xiii-577, figs. 1-174.

Refers to certain Mexican species.

OGHOTERENA, ISAAC.

1932. Nota acerca de la histologia de la piel de *Dermophis mexicanus* Dum. y Bibr. Anal. Inst. Biol., 3, No. 4, 1932, pp. 363-369, text figs. 1-9.

OLIVER, JAMES A.

1937. Notes on a collection of amphibians and reptiles from the state of Colima, Mexico. Occ. Papers Mus. Zool., Univ. Michigan, No. 300, Nov. 20, 1937, pp. 1-28, pl. 1, text fig. 1.

Discusses *Bufo marinus*, *B. marmoratus*, *B. simus*, *Leptodactylus melanonotus*, *Eleutherodactylus mexicanus*, *Pternohyla jodiens*, *Agalychnis dacnicolor*, *Hyla baudinii*, *H. smithii*, *H. venulosa*, *Hypopachus oxyrinus*, *Microhyla usta*, *Rana pipiens*, and *R. pustulosa*.

ORTON, GRACE.

1943. The tadpole of *Rhinophrynus dorsalis*. Occ. Pap. Mus. Zool. Univ. Mich., 472, pp. 1-3, pl. 1.

OSBORNE, HENRY LESLIE.

1900. A remarkable axolotl from North Dakota. American Naturalist, 34, No. 403, July 1900, pp. 551-562, figs. 1-4.

1901. On some points in the anatomy of a collection of axolotls from Colorado, and a specimen from North Dakota. American Naturalist, 35, No. 419, Nov. 1901, pp. 887-902, figs. 1-6.

Mentions the Mexican axolotl.

OWEN, RICHARD.

1844. Characters of a new species of Axolotl. Ann. Mag. Nat. Hist., 15, No. 88, July, 1844, p. 23, 1 fig.

Axolotes a generic designation said to have been used by Cuvier first. *Axolotes guttatus* given as a new name for *Siredon mexicanus*; *Axolotes maculata* a new species described from "In Mexico, in fluviis Sierrae Madre, Chihuahua, lat. 26° 6' N., long. 106° 50' W."

PANCERI, PAOLO.

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1934. A monograph of the frogs of the family Microhylidae. London, 1934, pp. viii + 208, figs. 1-67.

Mexican forms discussed: *Hypopachus oxyrinus*, *Microhyla elegans* and *M. usta*.

PESTALOZZI, EMIL.

1878. Beitrag zur Kenntniss des Verdauungskanalns von *Siren pisciformis*. Verh. Phys.-medic. Ges. Würzburg, N. F., 12, 1878, pp. 83-102.

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1869. Eine Mittheilung über mexicanische Amphibien, welche Hr. Berkenbusch in Puebla auf Veranlassung des Hrn. Legationsraths von Schlozer dem zoologischen Museum gesandt hat. Monatsb. Akad. Wiss. Berlin, Dec. 1869, pp. 874-881.

Luuperus nitidus, *Hylodes Berkenbuschii* and *Hyla microtis* are described as new. *Rana haeleina*, *R. montezumae*, *Hyla eximia*, *Bufo compactilis* and *Engystoma mexicanum* are discussed or listed.

1871a. Ueber neue Amphibien (*Hemidactylus*, *Urosaura*, *Tropidolepisma*, *Geophis*, *Urieichis*, *Scaphiopus*, *Hoplocephalus*, *Rana*, *Entomoglossus*, *Cystignathus*, *Hylodes*, *Arthroleptis*, *Phyllobates*, *Cephomantis*), des Königl. Zoologischen Museums. Monatsb. Preuss. Akad. Wiss. Berlin, 1870 (1871), pp. 641-652, pls 1-2.

1871b. Ueber einige Arten der heretologischen Sammlung des Berliner zoologischen Museums. Monatsb. Akad. Wiss. Berlin, 1871, pp. 644-652.

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1879a. Eine Mittheilung über neue Amphibien des Kgl. Zoologischen Museum (*Euprepes*, *Acontias*, *Typhlops*, *Zamenis*, *Spilotes*, *Oedipus*). Monatsb. Akad. Wiss. Berlin, Aug. 1879, pp. 774-779, pl. 1.

Spelerpes (Oedipus) infuscatus described from Haiti. Probably referable to a Mexican form.

1879b. Ueber die Eintheilung der Caecilien und ins besondere über die Gattungen *Rhinatrema* und *Gymnopsis*. Monatsb. Akad. Wiss. Berlin, Nov. 24, 1879, pp. 924-943, 1 pl.

Comments on *Dermophis mexicanus* and *Gymnopsis multiplicata* (from Veragua).

1882. Neue Art der urodelen Batrachier, *Spelerpes (Oedipus) yucatanus*, n. sp., aus Yucatan (Central America). Sitzs. Ges. naturf. Fr. Berlin, Nov. 21, 1882, pp. 137-138.

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1867b. On the regeneration of the limbs in the Axolotl (*Siren pisciformis*). Ann. Mag. Nat. Hist., (3), 20, 1867, p. 149.

1867c. Sur la régénération des membres chez l'axolotl (*Siren pisciformis*). Ann. Sci. Nat., Zool., Ser. 5, 7, 1867, p. 238.

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1872. (Développement des leucocytes chez les embryons d'axolotls.) Compt. Rend. et Mém. Soc. Biol. Paris, (5), 2, 1870 (1872) (Compt. Rend.), p. 59.
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1868. Siredon, a larval salamander. American Naturalist, 2, No. 9, Nov. 1868, p. 493.
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- REINHARDT, J., and LÜTKEN CH.
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- RICHARDSON, C. H., JR.
1912. The distribution of *Hyla arenicolor* Cope, with notes on its habits and variations. American Naturalist, 46, No. 550, Oct. 12, 1912, pp. 605-611, 1 map.
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RUTHVEN, ALEXANDER G.

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Reports *Dermophis mexicanus*, *Spelerpes variegatus*, *Rana austriicola*, *R. palmipes*, *Leptodactylus caliginosus*, *L. albilabris*, *Engystomops pustulosus*, *Bufo valliceps*, *B. marinus*, *Rhinophrynus dorsalis* and *Hyla baudini* from Veracruz.

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The following species are listed or discussed: *Hyla baudinii*, *H. staufferi*, *H. venulosa*, *H. miotympanum*, *Hylela* (sic) *picta*, *Leptodactylus melanotus* (sic), *Eleutherodactylus rhodopsis* (sic), *Syrhropus* (sic) *campi*, *Hypopachus cuneus*, *Rana pipiens*, *Bufo marinus*, *B. valliceps*, *B. punctatus*, *Scaphiopus hammondi multiplicatus*, *S. couchii*, *Triturus*, *kallerti* and *Oedipus platydactylus*.

SCANTIS, LEONE DE.

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The type description of *Oedipus flaviventris*. The following species of *Oedipus* are listed from Veracruz: *platydactylus*, *rufescens*, *lineolus*, *townsendi*, *chiropterus*, *bellii*, *pennatululus*, *cephalicus*, and *gadovii*.

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1944. Amphibians and reptiles of northern Coahuila, Mexico. Zool. Ser. Field Mus. Nat. Hist. 29 (6), pp. 97-115.

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1857. Deliciae Herpetologicae Musei Zoologici Cracoviensis. Beschreibung der in K. K. Museum zu Krakau befindlichen von J. v. Warszewicz in Neu-Granada und Bolivia gesammelten ungeschwänzten Batrachier. Denk. K. K. Akad. Wiss. Math.-Natur. Class, Wien, 14, pt. 2, 1857, (1858 ?), pp. 237-258, pls. 1-3, figs. 1-27.

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SCHNEIDER, G.

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SHAW, GEORGE.

1798. The Naturalists Miscellany, 9, 1798, pls. 343-344.

The type description of *Gyrinus mexicanus*. The plates are drawn by Frederic P. Nodder.

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Treats of *Siren pisciformis* and *Gyrinus mexicanus*; *Rana catesbeiana* is described.

SLEVIN, JOSEPH R.

1926. Notes on a collection of reptiles and amphibians from the Tres Marias and Revillagigedo Islands, and west coast of Mexico, with description of a new species of *Tantilla*. Proc. California Acad. Sci., (4), 15, No. 3, pp. 195-207, pl. 22, Apr. 26, 1926.

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1928. The amphibians of western North America. An account of the species known to inhabit California, Alaska, British Columbia, Washington, Oregon, Idaho, Utah, Nevada, Arizona, Sonora and Lower California. Occ. Papers California Acad. Sci., 16, Sept. 15, 1928. pp. 1-152, pls. 1-23.

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Bufo marinus, *B. valliceps*, *Tripidon petasatus*, *Hyla baudinii* and *Hypopachus cuneus* are listed from Yucatán; *Rhinophrynus dorsalis*, *Bufo marinus*, *B. valliceps*, *Engystomops pustulosus*, *Leptodactylus labialis*, *L. melanonotus*, *Agalychnis dacnicolor*, *Hyla baudinii*, *H. loquax*, *H. staufferi*, *H. underwoodi*, *H. venulosa*, *Hypopachus cuneus*, *Microhyla elegans*, *Rana palmipes*, *R. pipiens* are listed from Campeche.

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1941b. Snakes, frogs and bromelias, Chicago Nat., 4, No. 2, 1941, pp. 35-43, ill. *Oedipus platydactylus*, *O. rufescens*, *Hyla staufferi*, *H. baudinii*, *H. venulosa* are mentioned.

1943. Summary of the collections of snakes and crocodilians made in Mexico under the Walter Rathbone Bacon Traveling Scholarship. Proc. U. S. Nat. Mus., 93, pp. 393-504, figs. 13-15, pl. 32.
- 1944a. Additions to the list of Mexican amphibians and reptiles in the Carnegie Museum. Ann. Carn. Mus., 30, pp. 89-92.
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1933. Primera contribucion al conocimiento de los parásitos de *Rana mon-tezumae*. Anales del Instituto de Biología, 4. (1), pp. 15-21, 7 figs.
- SPEAR, JOHN C.
1872. Reports of explorations and surveys, to ascertain the practicability of a ship-canal between the Atlantic and Pacific Oceans, by way of the Isthmus of Tehuantepec. D. Report on the geology, mineralogy, natural history, inhabitants and agriculture of the Isthmus of Tehuantepec. Chapter V. Natural History. Cold-blooded vertebrates, determined by Edw. D. Cope. Washington. 42d Congress, 2d Sess., Senate Exec. Doc. No. 6, p. 137.
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Describes *Syrrophus campi* from Brownsville, Texas.

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1923. Idem. 2nd edit. 1923, pp. x + 171.
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- 1941a. Two new species of *Eleutherodactylus* from Guatemala. Proc. Biol. Soc. Wash. 54, pp. 197-200.

- 1941b. Another new *Hypopachus* from Guatemala. Proc. Biol. Soc. Washington, 54, Sept. 30, 1941, pp. 125-128.

Mentions the tadpoles of *Hypopachus cuneus nigroreticulatus* from Yucatán.

- 1942a. Descriptions of two new species of *Plectrohyla* Brocchi, with comments on several forms of tadpoles. Occ. Papers Mus. Zool. Univ. Michigan, No. 455, Jan. 5, 1942, pp. 1-14, figs. 1-4.

Forms compared with *P. sagorum* and *matudai* of Chiapas.

- 1942b. Una descripción preliminar de las provincias bióticas de Guatemala, fundada sobre la distribución del genero salamandrino. An. Soc. Geogr. Hist. Guatemala, 18, (1), pp. 29-38.

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- 1943b. Taxonomic and geographic comments on Guatemalan salamanders of the genus *Oedipus*. Misc. Publ. Mus. Zool. Univ. Mich. 56, pp. 1-33, pls. 1-3.

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1880. Contribución a l'Histoire naturelle du Mexique. 1. Notes sur une Collection de Reptiles et de Batraciens de la parte occidentale de l'Isthme de Tehuantepec. Bull. Soc. Zool. Fr., 5, 1880, pp. 162-190.

1882. Enumeracion de los batracios observados en la parte oriental y meridional de la República Mexicana. La Naturaleza, 6 Entrega 5, 1882, pp. 78-82, and Entrega 6, 1882, pp. 83-84.

Siphonops mexicanus, *Oedipus rufescens*, *O. carbonarius*, *O. salvini*, *Spelerpes belli*, *S. chiropterus*, *S. cephalicus*, *S. lineolus*, *Thorius pinnatulus*, *Bufo aquia*, *B. intermedius*, *B. sternosignatus*, *B. valliceps*, *B. christatus* (sic) *B. canaliferus*, ? *B. argillaceus*, *B. coccifer*, *Rhinophrynus dorsalis*, *Engystoma ustum*, *Microphryne (Paludicola) pustulosa*, *Syrrophus leprus*, *S. cystignathoides*, *Hylodes lithodytes rhodopis*, *H. griseus*, ? *Hylodes conspicillatus*, *Hylodes (Lithodytes) podiciferus*, *Lihyla rugulosa*, *Hyla myotympanum* (sic), *H. distincta*, *H. spilomma*, *H. staufferi*, ? *Hyla lichenosa*, *H. eximia*, *H. baudinii*, *Hylella platycephala*, *Agalychnis callidryas*, *Cystignathus* (sic) *melanonotus*, ? *Leptodactylus echinatus*, ? *Leptodactylus caliginosus*, *Cystignathus labialis*, *C. albilabris*, *C. caliginosus*, *C. gracilis*, *C. fragilis*, *Rana halecina*, *R. (Ranula affinis)*, ? *Rana valliantii*, ? *Rana maculata*.

1881. Note additionnelle a la première contribution a l'histoire naturelle du Mexique. Bull. Soc. Zool. France, 6, 1881, pp. 231-232.

Oedipus rufescens, *O. carbonarius*, *Bufo coccifer*, *Hyla myotympanum*, *Hylella platycephala*, *Lithodytes podiciferus*, *Syrrophus leprus*, *Cystignathus perlaevis*, *C. labialis* are listed and discussed.

1881-

1882. Contribucion a la historia natural de Mexico. I. Notas acerca de una coleccion de reptiles y batracios de la parte occidental del istmo de Tehuantepec. La Naturaleza, 5, Entrega 16, 1881, pp. 268-270; Entrega 17, 1882, pp. 271-286; Entrega 18, 1882, pp. 287-293.

Rhinophrynus dorsalis, *Engystoma ustum*, *Bufo aquia*, *B. sternosignatus*, *B. valliceps*, *B. argillaceus*, *B. canaliferus*, *Microphryne (Paludicola) pustulosa*, *Cystignathus melanonotus*, *C. gracilis*, *Rana halecina*, var. *berlandieri* ? *Rana (Ranula) affinis*, *Hylodes (Lithodytes) rhodopis*, *H. sallaei*, *Hyla rugulosa*, *H. (Smilisca) baudinii*, *H. staufferi*, *Oedipus Salvini*, *Siphonops mexicanus*, *Bufo coccifer*, *Cystignathus labialis*, *C. perlaevis*, *Hylodes (Lithodytes) podiciferus*, *Syrrophus leprus*, *Hylella platycephala* and *Oedipus rufescens*.

This is a translation from the French article, translated by D. Manuel Urbina. There is an "Adicion a la memoria anterior."

SUTTON, GEORGE MIKSCH and PETTINGILL, OLIN SEWALL, JR.

1942. Birds of the Gomes Farias region, southwestern Tamaulipas. Auk, 59, pp. 1-34, pls. 1-6.

TANNER, VASCO M.

1939. A study of the genus *Scaphiopus*; the spadefoot toads, Great Basin Nat., 1, No. 1, July 25, 1939, pp. 3-26, pls. 1-3.

TAUSCHENBERG, DR. O.

1894. Bibliotheca Zoologica II, Vol. 4. Leipsig, 1894, p. 3546.

Refers *Siredon dumerilii*, *Humboldtii lichenoides*, *mexicanus pisciformis*, and *tigrinus* to *Amblystoma tigrinum*.

TAYLOR, EDWARD HARRISON.

1933. Notes on type specimens of reptiles and amphibians in the "Alfredo Duges" Museum, Guanajuato, Mexico. *Copeia*, No. 2, July 20, 1933, p. 97.

Ambystoma altamirani reported.

- 1937a. New species of Amphibia from Mexico. *Trans. Kansas Acad. Sci.*, 39, 1936, (1937), pp. 349-363, pls. 1-2.

Original descriptions of *Leptodactylus occidentalis*, *Eleutherodactylus pygmaeus*, *E. hobartsmithi*. The species *Hyla smithii* is discussed. All are figured.

- 1937b. New species of hylid frogs from Mexico with comments on the rare *Hyla bistincta* Cope. *Proc. Biol. Soc. Washington*, 50, Apr. 21, 1937, pp. 43-54, pls. 2-3.

Type descriptions of *Hyla robertmertensi*, *Hyla pinorum*, *Hyla erythromma* and a discussion of *Hyla bistincta*. All species figured.

- 1938a. Notes on the herpetological fauna of the Mexican state of Sonora. *Univ. Kansas Sci. Bull.*, 24, No. 19, 1936 (Pub. date Feb. 16, 1938), pp. 475-503, pl. 43.

The following species are reported from Sonora: *Scaphiopus couchii*, *Bufo alvarius*, *B. punctatus*, *Hyla arenicolor*, *Rana pipiens*, *Pterohyla jodiens*, *Microhyla olivacea*, *Bufo woodhousii*, *B. marinus* and *B. compactilis*.

- 1938b. Notes on the herpetological fauna of the Mexican state of Sinaloa. *Univ. Kansas Sci. Bull.*, 24, No. 20, 1936 (Feb. 16, 1938), pp. 505-537, pls. 44-46.

Discusses *Scaphiopus couchii*, *Bufo marinus*, *B. punctatus*, *B. valliceps*, *Leptodactylus occidentalis*, *Pterohyla jodiens*, *Diaglena spatulata*, *Agalychnis dacnicolor*, *Hyla baudinii*, *H. smithi*, *Microhyla olivacea*, *Rana pipiens*. The toad *Bufo kelloggi* is described as new.

- 1939a. Concerning Mexican salamanders. *Univ. Kansas Sci. Bull.*, 25, No. 14, 1938 (July 10, 1939), pp. 259-313, pls. 24-29.

Type descriptions of the following species appear: *Ambystoma schmidti*, *Oedipus giganteus*, *O. smithi*, *O. altamontanus*, *O. manni*, *O. robertsi*, *O. multidentatus*. The following are discussed: *Rhyacosciredon altamirani*, *Oedipus bellii*, *O. leprosus*, *O. orisabensis*, *O. cephalicus*, *O. chiropterus*, *O. pennatulus*, *O. lineolus*, *O. salvinii* (= *Bolitoglossa flaviventris* [Schmidt]), *O. platydactylus* and *Gymnopsis multiplicata oaxacae*.

- 1939b. New species of Mexican tailless Amphibia. *Univ. Kansas Sci. Bull.*, 25, No. 17, 1938 (mailing date July 10, 1939), pp. 385-406, pls. 39-41, text figs. 1-2.

Type descriptions of *Hyla richardsi*, *H. arborescendens*, *Eleutherodactylus cactorum*, *E. natator*, *Rana sierramadrensis*. All species are figured.

- 1939c. Frogs of the *Hyla eximia* group in Mexico, with descriptions of two new species. *Univ. Kansas Sci. Bull.*, 25, No. 19, 1938 (July 10, 1939), pp. 421-445, pls. 46-48.

Type descriptions of *Hyla cardenasi*, *Hyla wrightorum*, *Hyla eximia*, *Hyla euphorbiacea*, *Hyla lafrentsi* and *Hyla regilla* are listed or discussed. Figures are given of most of the species.

- 1939d. A new bromeliad frog. *Copeia*, No. 2, July 12, 1939, pp. 97-100, fig. 1. *Hyla bromeliana* is described and figured.

- 1940a. A new eleutherodactylid frog from Mexico. *Proc. New England Zool. Club*, 18, Jan. 24, 1940, pp. 13-16, pls. 1-2.
Type description of *Eleutherodactylus batrachylus* from Miquihuana, Tamaulipas, México.
- 1940b. A new *Rhyacosiredon* (Caudata) from western Mexico. *Herpetologica*, 1, No. 1, Jan. 29, 1940, pp. 171-176, pl. 17.
Rhyacosiredon rivularis is described as new. This and *Rhyacosiredon altamirani* are figured.
- 1940c. A new bromeliad frog from northwestern Michoacan. *Copeia*, No. 1, Mar. 30, 1940, pp. 18-20, fig. 1.
Hyla smaragdina is described and figured.
- 1940d. Two new anuran amphibians from Mexico. *Proc. U. S. Nat. Mus.*, 89, No. 3093, 1940, pp. 43-47, pls. 1-3.
Describes *Syrrophus smithi*, *Hyla dendroscarta*. Both species are figured, including the tadpoles of the latter.
- 1940e. A new *Syrrophus* from Guerrero, Mexico. *Proc. Biol. Soc. Washington*, 53, Oct. 7, 1940, pp. 95-98, pl. 1.
Syrrophus pipilans is described and figured.
- 1940f. New species of Mexican anura. *Univ. Kansas Sci. Bull.*, 26, No. 11, 1940 (Nov. 27), pp. 385-405, pls. 43-44, text figs. 1-3.
Type descriptions of *Hyla hazelae*, *Hyla robustofemora*, *Hyla robertsororum*, *Syrrophus latodactylus* and *Eleutherodactylus vocalis* appear.
- 1940g. New salamanders from Mexico with a discussion of certain known forms. *Univ. Kansas Sci. Bull.*, 26, No. 12, 1940 (Nov. 27), pp. 407-439, pls. 45-48, text figs. 1-5.
Contains type descriptions of the following species: *Bolitoglossa dimidiata*, *Thorius pulmonaris*, *Thorius narisovalis*, *Ambystoma bombypella*, *Ambystoma amblycephala*, *Ambystoma ordinaria* and *Siredon lermaensis*. All are figured. The following are mentioned or discussed: *Thorius pennatulius* (= *Thorius troglodytes* and *Thorius dubitus*), *Siredon mexicana* and *Siredon dumerelli*.
- 1940h. Herpetological miscellany No. I. *Univ. Kansas Sci. Bull.*, 26, No. 15, 1940 (Nov. 27), pp. 459-571, pls. 53-63, text figs. 1-7.
Type descriptions of *Bufo gemmifer*, *Bufo mazatlanensis*, *Tomodactylus angustidigitorum*, *Tomodactylus macrotympanum*, *Microbatrachylus* new genus, *Microbatrachylus albolabris*, *Microbatrachylus oaxacae*, *Microtrachylus minimus*, *Hyla melanomma*, *Hyla forbesi*, *Hypopachus cuneus nigroreticulatus*, *Hypopachus ovis*, *Hypopachus alboventer*, *Hypopachus maculatus* and *Hypopachus caprimimus*. The following species are discussed: *Microbatrachylus pygmaeus*, *M. hobartsmithi*, *Hyla arboreascendens*, *H. erythromma*, *Hypopachus* (genus), *Hypopachus cuneus cuneus*, *Microhyla elegans*, *M. olivacea*. The new species and certain of the others are figured.
- 1940i. A new frog from the Tarahumara Mountains of Mexico. *Copeia*, Dec. 27, 1940, No. 4, pp. 250-253, fig. 1.
Type description of *Eleutherodactylus tarahumaraensis* from Mojarachic, Chihuahua, México.
- 1941a. New plethodont salamanders from Mexico. *Herpetologica*, 2, No. 3, Mar. 25, 1941, pp. 57-65, figs. 1-5.
Contains type descriptions of *Bolitoglossa unguidentis* from Cerro San Felipe, Oaxaca, and *Bolitoglossa arborea* from near Tianguistengo, Hidalgo. The premaxillary teeth of *Bolitoglossa smithi* are figured.

Eleutherodactylus sp. (= *E. hidalgoensis*), *Syrrophus latodactylus*, *Tomodactylus macrotympanum* are mentioned or discussed. Figures are given of *Eleutherodactylus occidentalis*, *E. saltator*, *E. calcitrans*, the new species, and the various species of *Thorius*.

- 1941e. New amphibians from the Hobart M. Smith Mexican collections. Univ. Kansas Sci. Bull., 27, pt. 1, No. 8, Dec. 15, 1941, pp. 141-167, pls. 7-11, text fig. 1.

Type descriptions are given of *Bolitoglossa nigromaculata*, *Bolitoglossa occidentalis*, *Bolitoglossa zolocalcas*, *Bolitoglossa nigroflavescens*, *Eleutherodactylus dorsoconcolor*, *Eleutherodactylus matudai*. All of the species are figured.

- 1942a. Tadpoles of Mexican anura. Univ. Kansas Sci. Bull., 28, pt. 1, No. 3, May 15, 1942, pp. 37-55, pls. 1-3.

Tadpoles of Genus sp.?, *Plectrohyla matudai*, *Agalychnis dactinicolor*, *A. callidryas* (eggs), *Scaphiopus multiplicatus*, *Rana pustulosus*, *R. montezumae*, *Hypopachus caprimimus*, *H. alboventer*.

- 1942b. The frog genus *Diaglena*, with a description of a new species. Univ. Kansas Sci. Bull. 28, pt. 1, No. 4, May 15, 1942, pp. 57-65, pls. 4-5.

Type description of *Diaglena reticulata* with a discussion of the genus and of *Diaglena spatulata*.

- 1942c. New tailless amphibia from Mexico. Univ. Kansas Sci. Bull., 28, pt. 1, No. 5, May 15, 1942, pp. 67-89, pls. 6-9.

Type descriptions of the following appear: *Microbatrachylus montanus*, *M. imitator*, *Eleutherodactylus maddougalli*, *Centrolenella viridissima*, *Hyla rozeae*. Discussions of specimens of the following: *Eleutherodactylus mexicanus*, *Centrolenella fleischmanni*, *Hyla leucophyllata*, and *Hyla phasota*. Most of the species are figured.

- 1942d. New Caudata and Salientia from Mexico. Univ. Kansas Sci. Bull., 28, pt. 2, No. 14, November 15, 1942, pp. 295-323, pls. 28-29.

The following new species are described: *Syrrophus modestus* from Paso del Río, Colima, *Hyla beltrani*, Tapachula, Chiapas, *Eleutherodactylus bolivari*, Ixtapan del Oro, México, *Eleutherodactylus decoratus*, Banderia, Veracruz, *Eleutherodactylus hidalgoensis*, near Tinguistengo, Hidalgo.

- 1943a. A new *Hylella* from Mexico. Proc. Biol. Soc. Washington 56, pp. 49-52. *Hylella asteca* described.

- 1943b. A new ambystomid salamander adapted to brackish water. Copeia 3, pp. 151-156, figs. 1-3.

Ambystoma subnaleum described.

- 1943c. Herpetological novelties from Mexico. Univ. Kansas Sci. Bull., 29 (2), pp. 342-361, pls. 26-27.

Bolitoglossa cochranae, *Rhyacospiredon leoras*, *Bufo perplexus*, *Bufo nayaritensis*, *Tomodactylus albolabris*, *Syrrophus nebulosus* and *Microhyla masatlanensis* are described.

- 1944a. A new genus and species of Mexican hylid frogs. Univ. Kansas Sci. Bull., 30 (1) (3), pp. 41-45.

Ptychohyla adipiventris described.

- 1944b. A new ambystomid salamander from the plateau region of Mexico. Univ. Kansas Sci. Bull., 30 (1) (5), pp. 57-61, pl. 8.

Ambystoma granulorum described.

- 1944c. The hylid genus *Aerodytes*, with comments on Mexican forms. Univ. Kansas Sci. Bull., 30 (1) (6), pp. 63-69, pl. 9.

Aerodytes inflata described.

- 1944d. Present location of certain herpetological and other type specimens. Univ. Kansas Sci. Bull., 30 (1) (11), pp. 117-187.
- 1944e. The genera of plethodont salamanders in Mexico, Pt. I. Univ. Kansas Sci. Bull., 30 (1) (12), pp. 189-232, pls. 12-15, figs. 1-2. Defines the new genera *Chiropoterotriton*, *Pseudoeurycea Parvimolge* and *Magnadigitia*.
- TAYLOR, EDWARD H. and KNOBLOCH, IRVING W.
1940. Report on an herpetological collection from the Sierra Madre Mountains of Chihuahua. Proc. Biol. Soc. Washington, 53, Oct. 7, 1940, pp. 125-130.
Lists *Bufo simus*, *Hyla arenicolor* and *Rana pipiens*. Mentions *Ambystoma* larvae.
- TAYLOR, EDWARD H. and SMITH, HOBART M.
1945. Summary of the collections of amphibians made in Mexico under the Walter Rathbone Bacon Traveling Scholarship. Proc. U. S. Nat. Mus. 95 (3185), pp. 521-613, pls. 18-32, figs. 58-61.
One hundred forty-six species discussed. Eight new forms are described: *Rhyacosiredon zempolaensis*, *Ambystoma lacustris*, *Bolitoglossa cephalica rubrimembris*, *Bufo angustipes*, *Eleutherodactylus conspicuus*, *Eleutherodactylus avocalis*, *Syrrophophus rubrimaculatus* and *Acrodytes modesta*.
- TAYLOR, EDWARD H. and WRIGHT, JOHN SUAREZ.
1932. The toad *Bufo marinus* (Linnaeus) in Texas. Univ. Kansas Sci. Bull., 20, No. 12, 1932 (Oct. 1), pp. 247-249.
Bufo marinus mentioned in México.
- TEGETMEIER, WILLIAM BERNHARD.
1870. (Exhibition of living specimens of the Axolotl.) Proc. Zool. Soc. London, 1870, pp. 160-161, figs. 1-2.
An axolotl and a transformed specimen are figured, purporting to be *Siredon mexicanus*.
- TERRON, CARLOS CUESTA.
1921. Datos para una Monographia de la fauna Erpetologica de la peninsula de la Baja California. Mem. Soc. Cien. Antonio Alsate, Tomo 39, pp. 161-171.
Numerous species listed.
1930. La *Hyla eximia* Baird. Anales del Inst. de Biologia, I, (2), pp. 47-50, figs. 1-4.
- TEST, FREDERICK CLEVELAND.
1898. A contribution to the knowledge of the variations of the tree frog *Hyla regilla*. Proc. U. S. Nat. Mus., 21, No. 1156, 1898, pp. 477-492, pl. 39.
Hyla curta and *Hyla regilla laticeps* are placed in the synonymy of *Hyla regilla*.
- TEVIS, LLOYD.
1944. Herpetological notes from Lower California. Copeia, 1, pp. 6-18, figs. 1-2.
- TÖRÖK, AURÉL.
1872. A mexikoi Proteus vagy Axolotl. Természet. 4 évf. 1872, 18ss., pp. 186-191.

1877a. Dolgasotok a klossvari t. egyetem élet-és ovettani intézetéből. II. Szövetalakulasok a Siredon pisciformis. Seiteiben. Adat asállati szerveszet ssövetfejlődésanahos. Erdél. Museum Egylet. Evkönyv. Uj Folyam. II. Köt. 5, szam. 1877, pp. 144-170 (with a German abstract).

1877b. Überblick des ungarischen Textes über formative Differenzirungen in den Embryonalsellen von *Siredon pisciformis*. *ibid.* pp. 171-172.

1877c. Über formative Differenzirungen in den Embryonalsellen von *Siredon pisciformis*. Ein Beitrag zur Histiogenese des Tierorganismus. *Arch. Mikr. Anat.*, 13, 1877, pp. 756-783.

TSCHUDI, JOHANN JACOB VON.

1839. Classification der Batrachier mit Berücksichtigung der fossilen Thiere dieser Abtheilung. *Mem. Soc. Sci. Nat. Neuchâtel*, 2, 1839, pp. 1-100.

TWITTY, VICTOR CHANDLER.

1941. Data on the life history of *Ambystoma tigrinum californiense* Gray. *Copeia*, No. 1, Mar. 25, 1941, pp. 1-4.

States that *Ambystoma tigrinum californiense* has been artificially hybridized with *S. mexicanum*.

1942. The species of Californian Triturus. *Copeia*, No. 2, July 10, 1942, pp. 65-76, pls. 1-5.

TWITTY, VICTOR C., and ELLIOT, H. A.

1934. The relative growth of the amphibian eye, studied by means of transplantation. *Journ. Exper. Zool.*, 68, 1934, pp. 247-291, 22 text figs. *Siredon mexicanum* mentioned.

VALLIANT, L.

1876. Sur la ponte des Axolotls transformés. *Bull. Soc. Philom. Paris*, 1876, pp. 13-15.

VAN DENBURGH, JOHN.

1896a. A review of the herpetology of Lower California, Part II, Batrachians. *Proc. California Acad. Sci.* (2), 5, 1896 (Jan. 15, 1896), pp. 556-561.

The following species are listed: *Hyla regilla*, *H. curta*, *Scaphiopus couchii*, *Bufo punctatus*, *Batrachoseps attenuatus* and *Plethodon croceator*.

1896b. Additional notes on the herpetology of Lower California. *Proc. Calif. Acad. Sci.*, (2), 5, 1896, pp. 1004-1008.

1905. The reptiles and amphibians of the islands of the Pacific Coast of North America from the Farallons to Cape San Lucas and the Revilla Gigedos. *Proc. California Acad. Sci.* (3), Zool. 4, No. 1, June 13, 1905, pp. 1-40, pls. 1-8.

Hyla regilla is reported from Cedros Island, Baja California.

VAN DENBURGH, JOHN, and SLEVIN, JOSEPH R.

1914. Reptiles and amphibians of the islands of the west coast of North America. *Proc. California Acad. Sci.*, (4), 4, Dec. 30, 1914, pp. 129-152.

Lists *Batrachoseps attenuatus* and *Autodax lugubris* from Los Coronados Islands; and *Hyla regilla* from Cedros Island.

1921. A list of the amphibians and reptiles of the peninsula of Lower California, with notes on the species in the collection of the Academy. *Proc. California Acad. Sci.*, (4), 11, No. 4, July 8, 1921, pp. 49-73.

The following species are listed or discussed: *Batrachoseps attenuatus*, *Plethodon croceator* (*Anides lugubris lugubris*), *Scaphiopus couchii*, *Bufo boreas halophilus*, *B. punctatus*, *Hyla regilla*, *H. arenicolor*, and *Rana draytoni*.

VELASCO, ALFONSO LUIS.

1894. Geografía y estadística del estado de Zacatecas. Geograf. Estadist. Republica Mexicana, Vol. 15 (Mexico), 1894, pp. 1-324.

Lists *Rana haelecina*, *Scaphiopus Holbrookii*, *Hyla eximia*, *Hyla versicolor*, *Hylodes laticeps*, *Bufo aqua*, *B. anomalus*, *B. intermedius*, *B. Chilensis*.

VELASCO, JOSÉ MARIA.

1879. Description metamorphosis y costumbres de una especie nueva del genero *Siredon*. La Naturaleza, 4, 1879, pp. 209-233, pls. 7-9.

1880. Anotaciones y observaciones al trabajo del Sr. D. A. Weismann sobre la trasformacion del ajolote mexicano en *Amblystoma*. La Naturaleza, 5, Entrega 3, p. 58; Entrega 4, pp. 59-74; Entrega 5, pp. 75-84.

The author's name appears on the covers of the various entregas but not with the title of the articles.

VETTER, B.

1877. über die Umwandlung des mexicanischen Acolotl in die *Amblystoma*-form. Nach A. Weismann. Sitzber. Ges. Isis Dresden, 1876 (1877), pp. 28-29.

VILLADA, MANUEL M.

1879. Dictámenes acerca del trabajo anterior. La Naturaleza, 4, 1879, pp. 234-236.

Remarks on Velasco's article (1879) on *Siredon tigrina*.

VION, RENE.

1869. Les Axolotls, compte-rendu d'une leçon de M. Aug. Duméril. Bull. Soc. Linn. Nord France, 1, 1866-67 (1869), pp. 421-431.

VULPIAN, A.

1867. Sur la reproduction des membres chez l'axolotl dans le cas de polydactylie acquise. Bull. Soc. Philom. Paris, (6), 4, 1867, p. 117.

WAGLER, JOHAN.

- 1828-1833. Descriptiones et Icones Amphibiorum. 3 parts. 36 pls.; pt. 1, 1828; pt. 2, 1830; pt. 3, 1833.

Siredon axolotl, pl. 20.

1830. Natürliches System der Amphibien mit vorangehender Classification der Säugethiere und Vogel. Ein Beitrag zur vergleichender Zoologie. Munchen, Stuttgart und Tübingen, 1830, pp. 1-354.

WALKER, CHARLES F.

1938. The structure and systematic relationships of the genus *Rhinophrynus*. Occ. Papers Mus. Zool., Univ. Michigan, No. 372, May 25, 1938, pp. 1-11, figs. 1-3.

Believes the genus worthy of family rank.

WEISMANN, DR. AUGUST.

1872. Ueber den Einfluss der Isolirung auf die Artbildung. Leipzig, 1872, pp.

Probably not *Siredon mexicana*.

1875. Ueber die Umwandlung des mexicanischen Axolotl in ein *Amblystoma*. Zeit. wiss. Zool., 25, Heft 3, suppl., 1875, pp. 297-334.

Treats of *Siredon mexicanus*.

1876. Axolotl u. *Amblystoma*. Zool. Garten, 17, 1876, pp. 1-8.

1878. On the change of the Mexican Axolotl to an *Amblystoma*. Ann. Rep. Smithsonian Inst., 1877 (1878), pp. 349-375.

1880. Transformacion del ajolote Mexicano en Amblystoma por el Señor Doctor Augusto Weismann. Traducido del Annual Report of the Smith. Inst., 1877, por el Sr. Miguel Perez. La Naturaleza, 5, Entrega 2, 1880, pp. 31-42; Entrega 3, 1880, pp. 43-57.

WERNER, FRANZ.

- 1894a. Über einige Novitäten der herpetologischen Sammlung des Wiener zoolog. verg. anat. Inst. Zool. Anz. 17, No. 446, May 7, 1894, pp. 155-157.

Type description of *Bufo lateralis* from Tehuantepec.

- 1894b. Bemerkungen über die nord-amerikanischen Rana-Arten. Jahresb. natur. Ver. Magdeburg, 1893 (1894), pp. 123-136.

Rana montezumae, *R. virescens sphenoccephala* are listed from México.

1896. Beiträge zur Kenntniss der Reptilien und Batrachier von Central Amerika und Chile, sowie einiger seltener Schlangenarten. Verh. Zool.-bot. Ges. Wien, 46, 1896, pp. 344-365, pl. VI.

Agalychnis moreletti.

1903. Ueber Reptilien und Batrachier aus Guatemala und China in der Zoologischen Staats-Sammlung in München, nebst einem Anhang über seltene Formen aus anderen Gebieten. Abh. Bayer. Akad. 2, 22, 1903, pp. 343-384, pls. & figs.

Describes *Spelerpes doffeini*.

WIEDERSHEIM, R.

1877. Das Kopfskelet der Urodelen, ein Beitrag zur vergleichenden Anatomie des Wirbelthier Schädels. Morph. Jahresb. 3, pp. 352-448, and pp. 459-548, pls. 19-28. Published separately in Leipzig, 1877, pp. 1-187, pl. 9.

Spelerpes sp., perhaps *pennatulus*, pp. 427, 482, 498; pl. 21, fig. 48; pl. 24, fig. 87; and *Spelerpes minimus*, p. 544, Veracruz.

1878. Zur Anatomie des Amblystoma Weismann. Zeit. wiss. Zool., 32, 1878 ?, pp. 216-236, pls. 11-12.

1879. Anatomie der Gymnophionen. 1879, pp.

1880. über die vermehrung des Os centrale im Carpus u. Tarsus des Axolotls. Morf. Jahrb., 6, 1880, pp. 581-583, 1 pl.

WILDER, H. H.

- Lungless salamanders. Anat. Anz. 12, pp. 182-192, 7 text figs.

WOLTERSTORFF, WILLY.

1925. Katalog der Amphibien-Sammlung im Museum für Natur und Heimatkunde zu Magdeburg. Erster Teil: Apoda, Caudata. Abh. Ber. Mus. Naturk. Heimat. Natur. Ver. Magdeburg, 4, No. 2, 1925, pp. 231-310.

Reports specimens of "*Amblystoma tigrinum*" from México. These include perhaps several species.

1930. Zur Systematic und Biologie der Urodelen Mexikos. In "Beiträge zur Herpetologie Mexikos." Abh. Ber. Mus. Naturk. Heimat. Natur. Ver. Magdeburg, 6, No. 2, 1930, pp. 129-149, 13 text figs.

Treats of *Amblystoma tigrinum*, *A. tigrinum velascoi* (type description; apparently described twice by two different authors in this work. A correction on page 145 states that the original reference in the Lafrents article should read "*Amblystoma tigrinum velascoi* Wolt. instead of *Amblystoma tigrinum velascoi*

subsp. nov.", *A. mexicanum*, *A. dumerili*, *A.* ^m (*Rhyacosedon*) *altamirani*, *Oedipus belli*, and *Diemictylus kallerti* (described as new).

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The following species are listed from México: *Rana halcinea berlandieri*, *R. montezumae*, *Scaphiopus couchii*, *S. varius varius*, *Spea multiplicata*, *Hyla arenicolor*, *H. eximia*, *H. regilla*, *H. curta*, *Bufo valliceps*, *B. lentiginosus cognatus*, *B. speciosus*, *B. beldingi*, *B. punctatus*, *B. debilis*, *Amblystoma mavortium* and *Siren lacertina*.

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